E ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JANUARY 19, 1939

echanization of sewage treatment is the trend of the times (see p. 89)

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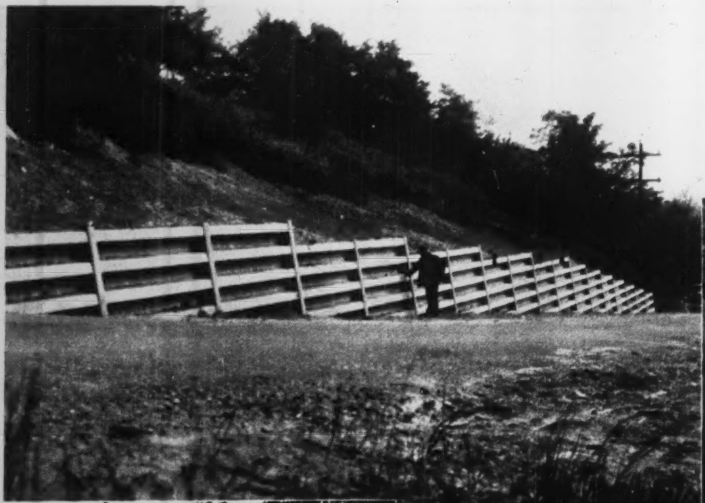
HOW TO BUILD RETAINING WALLS

Faster and at Lower Cost

1.



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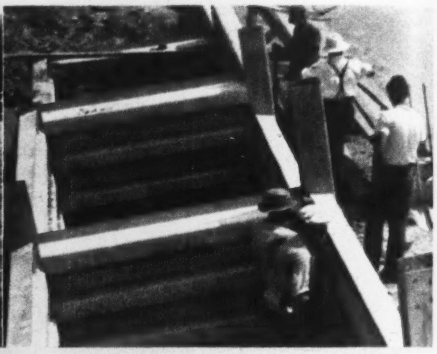

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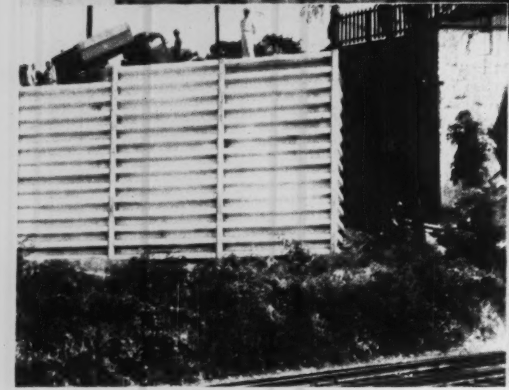

1. **Road maintenance costs dropped sharply when this sloughing hillside was stabilized by an Armco Bin-Type Wall 190 feet long with an average height of 9 feet. Notice how this neat-appearing wall lends itself to changes in elevation on this steep grade.**

2. **Here you see how the overlapping iron units are bolted to rigid U-shaped corner columns to form connected bins completely closed on all four sides. This type of construction enjoys wide acceptance among state highway departments and leading railroads.**

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• This year when you dig into those problems of repairing roadway slips, preventing washouts, or settling right-of-way disputes, you'll save in many ways by specifying Armco Bin-Type Retaining Walls.

Here is an improved cellular wall of iron that can be erected quickly in any season by local unskilled labor. Hand wrenches and shovels are the only tools needed, since the heaviest unit weighs only 140 pounds. Very little excavation is the rule—and as soon as a site is opened up and assembly started, the iron bins can immediately be filled with earth. This reduces the hazards of retaining wall construction along streams, and in unstable spots where sliding embankments might undermine the roadway.

Best of all, in an Armco Bin-Type Wall *lasting* stability is assured by sound engineering design. Individual units are supplied in a range of gages to meet varying earth pressures against the wall. There's no danger of cracking or bulging, because the finished structure has sufficient strength and flexibility to overcome unequal settlement. Since the units are fabricated from galvanized ARMCO Ingot Iron (proved by a third of a century of service) Bin-Type walls will serve for years. Write for the new 16-page catalog describing their practical advantages and uses. Armco Culvert Mfrs. Association, Middletown, Ohio.

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THE COVER PICTURE shows the lime feeding machine at the new activated sludge plant in Columbus, Ohio. It was taken by *ENR* Editor Cleary.

THIS WEEK

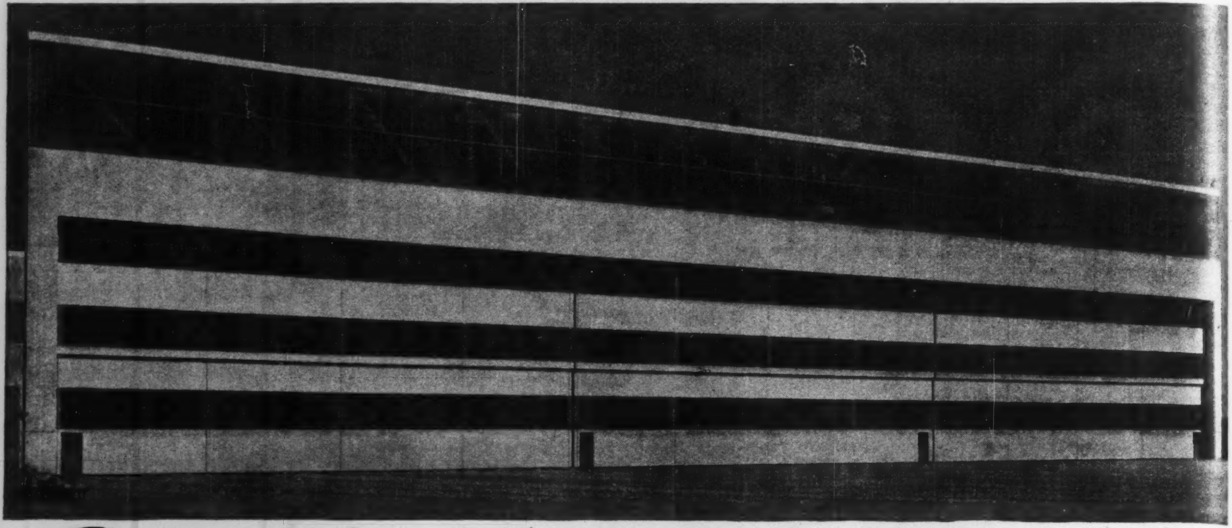
● Fulfilling faithfully the promise of earlier issues, this News-Technical number contains a large number of articles, concisely written and covering a wide field of subjects. Exclusive of regular features, such as Field and Office, editorials, etc., there are sixteen articles, ranging in length from less than a page to three pages.

● After many weeks of collecting, assembling and editing data on sewage disposal plants throughout the 48 states, *Engineering News-Record* presents in this issue a comprehensive analysis of the sanitary engineering field in the form of an insert (facing page 60) containing the results of this survey in handy tabular form. This brings surveys made three and ten years ago up to date.

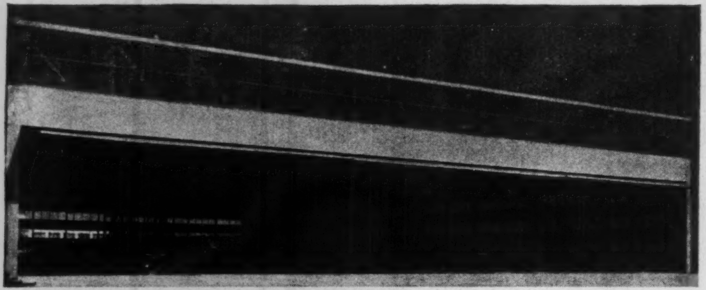
THINGS TO COME

Annual Review Number

THE NEXT News-Technical issue, dated Feb. 2, is the Annual Review Number. An outstanding feature, will be a profusely illustrated 16-page section presenting the status of the country's major construction projects and printed entirely by rotogravure. Other departments include the news summary for 1938, the editorial review, and the statistical summary of the construction year.



Biggest door of its type in the world



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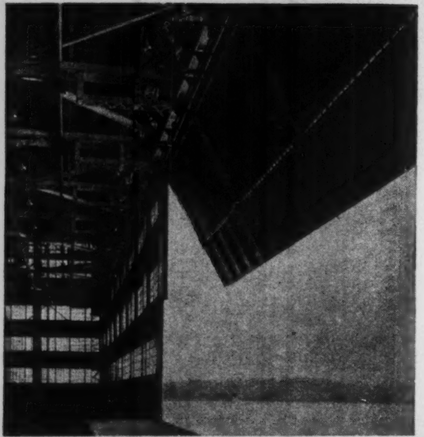
In 59 seconds, 12,795 square feet of steel and glass in this giant door are whisked to full open position. • Engineered and fabricated by Truscon for The Glenn L. Martin Company of Baltimore, the two-section high canopy type steel door is built in three units of equal width. • As required, each unit can be opened and closed independently of, or simultaneously with each or both of the other two units. This adaptability of the door to all conditions of use provides important safeguards against excessive heat loss. • Engineering and fabricating all designs and sizes of steel doors is a highly specialized activity of Truscon Steel Company. Name your need. Truscon can fill it.



The Truscon canopy type steel door illustrated is 300 ft. wide and 43 ft. 3" high.

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At left: a close-up view inside the door, showing part of the control mechanism.

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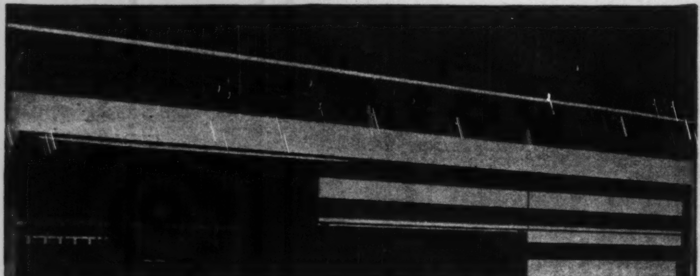
Below: each of the three door units can be opened and closed individually or simultaneously with either or both of the other two units.



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Steel company
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JANUARY 19, 1939

THE WEEK'S EVENTS

Senate Committee Would Cut WPA

Accepts House figures and recommends unified public works system for federal government

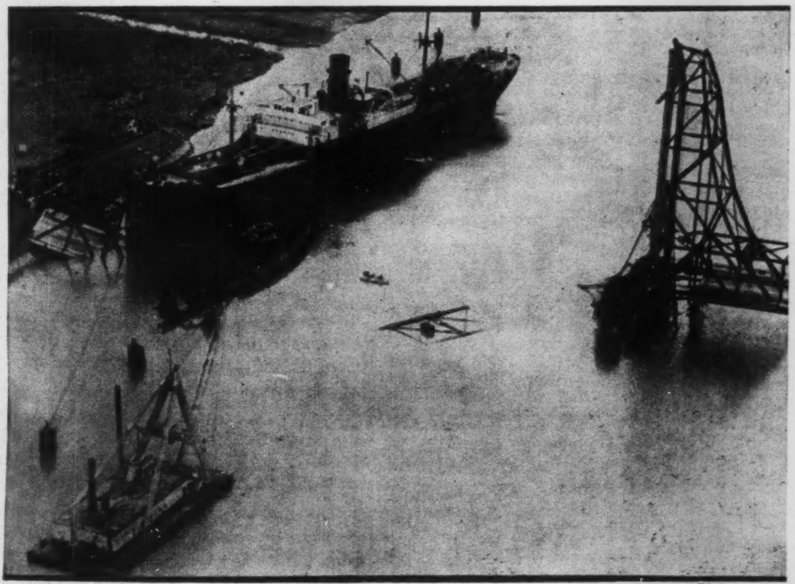
The fight of the Administration to restore the relief appropriation from the $725,000,000 voted last week by the House to the $875,000,000 originally asked by the President gradually changed in the Senate this week to a fight to protect the House figure from further cuts. Col. F. C. Harrington, who succeeded Harry L. Hopkins in charge of WPA, made a strong defense of the higher figure before the Senate Committee, but he made little progress against the insistance of many senators that it would be a comparatively simple matter to purge the relief lists sufficiently to permit the cut.

Meanwhile senators and House members studied the recommendation of the Senate committee on unemployment and relief that all relief activities, including PWA, WPA, CCC, NYA, etc., be combined in a Department of Public Works, or in a division of public works in an existing department.

"We should have one public-works program, administered preferably by a Department of Public Works," the committee declared in its report.

"There should be one office where unemployment benefits will be granted and where the employment service will aid a man to secure private employment. There should also be a Department of Public Works providing a work program based upon current advices as to unemployment throughout

(*Continued on p.* 39)



Pictures Inc.

FREIGHTER WRECKS CANAL BRIDGE

MOVING west toward Baltimore Jan. 10 on the Chesapeake and Delaware Canal sixteen miles south of Wilmington, the 6,000-ton freighter "Waukegan" went out of control and crashed into the north approach of the 160-ft. vertical lift bridge which carries the du Pont highway across the canal. (*ENR*, Jan. 12, 1939, p. 1).

The bridge was raised to its full 150-ft. height at the time, and when the north tower, with the control cabin, was knocked over, the lift span itself also dropped into the river. The north approach span was also wrecked. The south cables were broken, and part of the south tower collapsed.

The bridge operator in the control house was killed at once, and the bridge electrician died a few days later.

Vermont Attacks Flood Control Plan

President offers to drop Vermont projects as state objects to federal control

Continuation of the federal government's Connecticut Basin flood control projects in Vermont and possibly in other New England States was placed in doubt last week when Governor Aiken of Vermont asked and received from his state legislature funds with which to oppose in the courts the federal government's plan to carry out a flood control project without obtaining the consent of the state.

As a result of this action, President Roosevelt announced, through his secretary, that if Vermont objected to the procedure being used, the project would be cancelled. "Other states want and can use the money," the secretary asserted.

Governor Aiken's position was upheld by the governors of the six other New England states. Gathered at a conference of New England governors in Boston, they adopted a resolution urging the federal government "to cooperate with the New England states to accomplish flood control without demanding the complete surrender to

(*Continued on p.* 41)

• • •

Guntersville Dam Is Completed

With the last construction operation on TVA's Guntersville dam—placing of concrete in the upper miter sill of the locks—completed six weeks ahead of schedule, the eighteen gates of the dam were closed Jan. 16, and the reservoir began to fill. Within two weeks the reservoir level will be high enough to permit resumption of navigation through the dam locks, which have been closed since Dec. 15 when the final concreting work was begun.

It is expected that the first power unit for Guntersville will be in service by next October, and all three of the 34,000-generators will be operating within three months thereafter. Space is provided for a fourth generator.

Army Engineers Report Flood and Harbor Jobs

Chief of Engineers lists approved flood control and river and harbor projects

The annual report of the Chief of Engineers, made public Jan. 16, estimates that $350,000,000 could profitably be expended during the fiscal year ending July 1, 1940, for flood control works and for improvement of rivers and harbors. This sum includes $248,280,000 for flood control, of which $51,000,000 is for work on the Mississippi River and its tributaries. For rivers and harbors, the Chief of Engineers approved $154,714,000, of which $51,738,000 would be for maintenance and $102,976,000 for new construction.

Budget estimates presented to Congress last week by President Roosevelt would allocate $221,000,000 for expenditure by the Corps of Engineers, an increase of $28,819,000 over the present fiscal year. Of this, $110,000,000 was to be devoted to flood control work, exclusive of the lower Mississippi.

Placing a project on the list of "profitable" work does not necessarily mean that it will be undertaken, but, in general, available funds are devoted to listed projects.

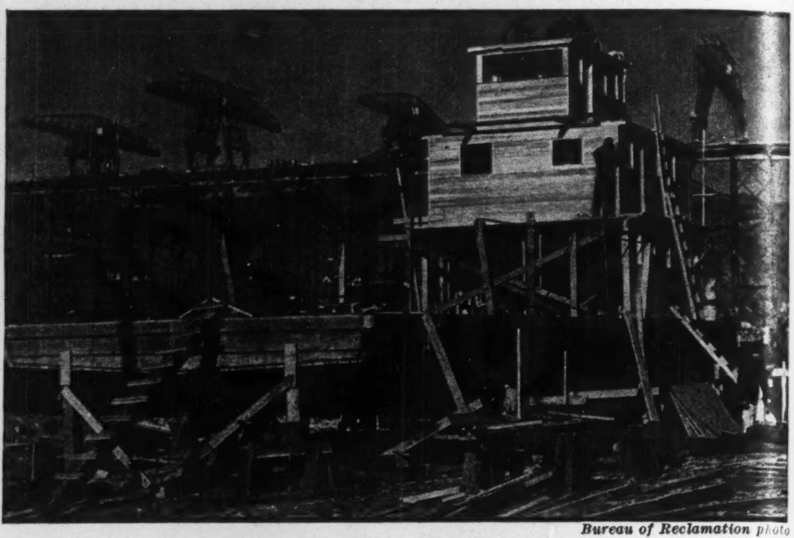
Larger projects listed by the army engineers are as follows:

RIVERS AND HARBORS
(New work only)

Projects	Amount
Boston harbor	$1,326,000
New York harbor	2,050,000
Hudson River	1,100,000
Great Lakes to Hudson River waterway	5,000,000
New York and New Jersey channel	5,000,000
Delaware River, Philadelphia to sea	3,500,000
Pearl River, Mississippi and Louisiana	1,800,000
Southwest Pass and South Pass, Mississippi River	1,694,000
Calcasieu River and Pass, Louisiana	1,500,000
Sabine-Neches Waterway, Texas	1,314,000
Louisiana - Texas intracoastal waterway	2,034,000
Buffalo Bayou, Texas	1,500,000
Mississippi River	13,944,000
Missouri River, mouth to Sioux City	9,885,000
Missouri River at Fort Peck	8,350,000
Illinois Waterway	2,622,000
Ohio River open channel	1,250,000
Saginaw River, Michigan	1,030,000
San Diego harbor	1,500,000
Columbia River	2,793,000
Columbia River at Bonneville	7,704,000
Sacramento River debris dam	3,600,000
TOTAL	$102,976,000

FLOOD CONTROL PROJECTS

Merrimack River reservoirs	9,000,000
Connecticut River reservoirs	4,410,000
Connecticut River	4,200,000
SOUTHERN NEW YORK PROJECTS	
Whitney Point reservoir	1,069,000
Hornel	400,000
Almond reservoir	1,182,000
Binghamton channel	2,500,000
Land, etc.	1,000,000
Additional reservoirs and channel improvements	2,859,000
Williamsport, Pa.	1,500,000
Codorus Creek, Pa.	1,625,000
Bayou Badeau, Louisiana	1,212,000
Memphis, Tenn.	2,628,000
Bois de Sioux River	1,474,000
Upper Mississippi, reservoirs and local projects	3,636,000
Mounds and Mound City, Ill.	2,000,000
Indianapolis Fall Creek levee	1,020,000
Evansville, Ind.	2,500,000
Paducah, Ky.	3,175,000
Tionesta Reservoir, Pa.	2,857,000
Crooked Creek reservoir, Pa.	2,185,000
Johnstown channel, Pa.	4,703,000
Mahoning Creek reservoir, Pa.	2,700,000
Red Bank reservoir, Pa.	3,000,000
Ironton, Ohio	1,710,000
Bluestone Reservoir, W. Va.	2,225,000
Ohio basin, reservoirs and local projects	18,071,000
Muskingum river reservoirs	2,000,000
Caddoa Reservoir, Colo.	3,500,000
Fort Supply reservoir, Okla.	2,392,000
Great Salt Plains, Okla.	1,867,000
Arkansas River basin	3,500,000
White River basin	3,293,000
Denison reservoir, Oklahoma and Texas	7,000,000
Missouri River basin	3,000,000
Kansas Citys	2,523,000
Los Angeles River drainage area	27,975,000
Santa Ana river basin	14,370,000
Columbia River basin	2,522,000
Willamette Basin	12,527,000
Mill Creek, Wash.	1,608,000
Mud Mountain dam, White River, Wash.	2,000,000
Mississippi River and Tributaries	50,000,000
Emergency work on the Mississippi tributaries	1,000,000
Sacramento River, Calif.	1,754,000
TOTAL	$248,280,000



Bureau of Reclamation photo

FIRST BOAT BEHIND COULEE DAM

NAVIGATION on the reservoir behind Grand Coulee Dam began early this month with launching of the diesel powered craft, "Paul Bunyan." The reservoir behind the dam is being cleared as a WPA project, and WPA workers built the barge to permit access to many parts of the river canyon which cannot be reached by road. Materials and mechanical equipment for the barge were furnished by the Bureau of Reclamation.

• • •

Half Million Damage Caused By Oregon Storm

Beginning Jan. 1 and lasting for several days, one of the most severe storms on the Oregon coast in more than 50 years did damage estimated at $500,000, mostly to beach property. The recently completed Sand Island dike in the Columbia River was severely damaged, and the spit across Tillamook Bay was broken through in three places, but otherwise little damage was done to levees in the area.

Oregon Coast highways were submerged in a number of places, but only one washout occurred; this took place at Bayocean, where a turn in the highway was completely carried away.

Newly-driven bents at the north jetty work on Coos Bay were destroyed, and false-work was lost.

• • •

Port Authority Crossings Have Less Traffic

Although opening of the Lincoln Tunnel brought the total vehicle traffic between New York and New Jersey through facilities of the Port of New York Authority to 23,378,000, or 3.3 per cent over 1937, traffic during 1938 on other structures of the authority was well under 1937 figures. Traffic in the Lincoln Tunnel was 1,790,000, considerably below expectations. This is believed to be due to the incomplete stage of the New Jersey approaches to the tunnel.

The Holland Tunnel was used by 12,453,000 vehicles in 1938, 4.8 per cent below 1937, while the George Washington bridge was 3.2 per cent below 1937 with traffic of 7,694,000. Traffic on the Bayonne Bridge, the Goethals Bridge, and the Outerbridge Crossing was 4.9, 6 and 4 per cent below 1937, respectively.

Traffic on all Port Authority facilities, however, was in excess of 1936 and most preceding years.

Engineers Union Opposed by Builders

New York builders, architects, engineers, and building trades condemn new engineers' union

Strong opposition to the Supervising Professional Engineers Union (*ENR* Jan. 12, p. 2) was expressed by builders, architects, engineers and the building trades unions at a meeting held Jan. 13 under the auspices of the New York Building Congress. Though invited to attend, officials of the new union were not present. Edwin A. Kingsley, a consulting engineer specializing in building inspection work, who has joined the union, attended but said that the union still is in the formative stage and has no objective or scheme of action which could be discussed.

As Mr. Kingsley's statements appeared to go contrary to a widely quoted Dow Service announcement of the formation of the union which gave its objectives in some detail, John W. Pickworth, the presiding officer, read extracts from the announcement and also read the *Engineering News-Record* report of an interview with Edmund J. McCormick, president of the union.

Mr. Kingsley held that any action opposing the union would be premature at this time because it had not yet set any objectives; but other speakers, in calling for opposition to the union, pointed out that it is actively engaged in seeking members, using copies of the Dow Service announcement for that purpose, also that in replying to returns from blind advertisements in the help-wanted columns of New York papers, the union is intimating that it has openings for 150 men in positions paying $125 a week.

Unions repudiate group

Opposition on the part of the building trades was expressed by C. W. Hanson, president of the Carpenters and Joiners District Council, who stated that his union is not and would not be a party to any plan to compel builders to employ inspectors from the engineers' union. Like opposition was expressed in a message from Thomas A. Murray, President of the New York Building and Construction Trades Council. This is the agency which would have to authorize any tie-up between the building trades unions and the engineers union by which the trade unions would refuse to work on jobs not employing a supervisor from the engineers union.

Architects, engineers and builders all expressed themselves as believing the building inspection service proposed by the new union to be not only unnecessary but positively disruptive to proper relations between owners, architects, engineers, contractors, and the building trades.

At the close of the meeting a resolution condemning the union as detrimental to all elements of the construction industry, presented by Wm. Joshua Barney, newly elected president of the Metropolitan Builders Assn., was unanimously adopted.

Engineers join opposition

Opposition to the new union was expressed Jan. 16 by Alfred E. Roche, president of the New York State Society of Professional Engineers, who stated that such a union is diametrically opposed to the fundamental concepts of the society. We recognize that unionization has its place, said Mr. Roche, "but professional men occupy a position of public trust between capital and labor and unionization is inconsistent with the highest discharge of that trust."

LABOR NOTES

Wage Minimums have been established for the steel industry by the Secretary of Labor under the terms of the Walsh-Healey government contracts act. Overruling the recommendation of the Public Contracts Board, the secretary established four zones with a 62.5c. an hour minimum in the northern states, 60c. in the West, 58.5c. in the Middle West, and 45c. in the South. The board had recommended that 62½c. be required of all steel companies bidding on government contracts except in the South, where 45c. was recommended.

Plumbers in New York City, members of Local 463 of the Journeymens Plumbers and Helpers Union, quit work Jan. 16. The Association of Master Plumbers of Manhattan and the Bronx, the employers group, had attempted, according to the union, to void a contract calling for a six hour day at $2 an hour and demanded that the men work at $1.50 per hr.

Flexible provisions of a new contract made by the Tacoma Building Trades Council with building contractors there provide that shifts may be worked during any hours of the day at regular pay schedules and also provide that overtime may be worked at straight-time pay if enough competent workmen are not available, at any time to meet the demand. The new contract continues the six hour day, the 30-hour week, and the 1938 wage scale for all crafts until Jan. 1, 1940.

Prefabricated Forms Cause Strike

After two week's strike, carpenters permit use of concrete forms already bought

Carpenters employed by a contractor on the Queensbridge USHA-financed housing project in New York City went on strike Dec. 30 in protest against the use of prefabricated plywood forms for concrete work. The job was held up until the carpenters went back to work Jan. 12, agreeing to permit the use of $30,000 worth of the forms which already had been purchased.

The Corbetta Construction Co., which holds the contract for foundation work on the project, and is also building the floor arches on a subcontract from the general contractor, Caldwell-Wingate Co., has been using a prefabricated plywood form set up in a Midwest factory ready for service. After these forms had been in service two weeks, the carpenters struck, and brought all structural work to a halt, insisting that the plywood be delivered to the job in stock sizes and cut and fabricated at the site.

President Hanson of the Carpenters District Council of Greater New York said the union was waiving its objections to use of the already purchased forms on the Queensbridge project because the union did not believe in the "destruction of materials." He said, however, that on future projects the union would insist on fabrication of the forms at the site.

• • •

Union Exempts Housing Job From Hours Demand

The Bricklayers, Masons and Plasterers Union of Elizabeth, N. J., has notified the U. S. Housing Authority that it will exempt USHA projects from demands which it is now making for shorter hours and a higher hourly wage. Although the union is now seeking new agreements reducing the present 8-hr. day at $1.50 an hr. to a 7-hr. day at a higher rate, the business agent of the union wrote that the members remain ready to work at the existing schedule on USHA jobs. "We do not intend to use housing as a club with which to raise wages or shorten hours," he said.

This is said by USHA officials to be the first such action by any building trades union. USHA requested the union to take this position because the other trades are working eight hours, and it was feared work would be disrupted and costs increased if the masons worked a shorter day.

A.E.C. Held Essential To Engineering Profession

Washington meeting of American Engineering Council studies relation of engineer to social processes

Relations between the engineering profession and various economic and governmental questions were discussed at a series of forums which composed the greater part of the program of the 19th annual assembly of American Engineering Council, held Jan. 12–14 at Washington. As is now customary, the secretaries of local, state, and national technical societies held their annual conference during the same period.

Especially noteworthy was an address by Dr. Vannevar Bush, new president of Carnegie Institute. Pointing to the medicine men of primitive tribes as the progenitors of the professional man today, Bush traced briefly the development of the principal professions—teaching, medicine, the law and, most recently, the yet unrecognized profession of corporate management.

Characteristics of a profession, Bush declared, derive from the attributes of the primitive medicine men. In the modern profession, to some degree, they include most of the following: A strict code of conduct, a training period for neophytes, restriction of membership, a special language, and, most essential of all, ministry in some way to the needs of the people.

Engineering, a relatively young profession, has grown too fast to have yet found itself. While it possesses to some extent most of the attributes outlined, it has yet to develop a body of codified principles accepted and applied by its membership as a whole. While it undoubtedly serves the public, it has not yet demonstrated a professional spirit of public service.

But there are signs of a rising consciousness in this regard, Bush said. Engineers are giving more thought to their position in society and their social responsibilities. The American Engineering Council focuses these efforts. More than any other group, he said, it represents the profession as a whole in its relationships with government, other professions, and the public. But as compared with the central bodies of sister professions, it is inadequately supported and it is still struggling for acceptance by the rank and file of engineers.

Yet Bush expressed the conviction that such an organization is necessary in the following words: "If there is no central organization which has as its creed the best service of the profession to the society of which it forms a part, there will be in the end no engineering profession. Professional status rests in perpetuity, not on transient law, not on the cruder machinations of the ancient guilds, not on exclusive control of those having a specialized and necessary knowledge, but upon the respect and fundamental support of the people who are served; who only, in the long run, can insist upon the maintenance of prerogatives and confer honor, recognition and special privileges in society upon the members of a profession."

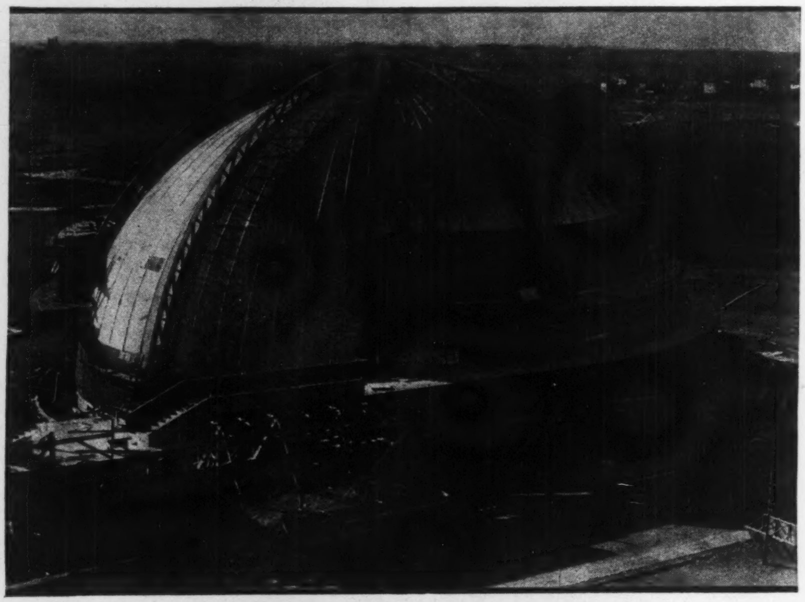
National planning

The first forum session had as its topic "National Planning and the Engineers' Relation to It." Harold G. Moulton, of the Brookings Institute, pointed out that the term "national planning" carries different meanings to different persons. Its objective is not new, for the progress of a nation as a whole has been desired by governing classes throughout history. The methods, however, are constantly changing. In this country today the term is generally applied to governmental efforts to combat the great weakness of the present economic system—violent fluctuations in the business cycle.

Charles W. Eliot, executive officer of the National Resources Committee, outlined principles governing present federal planning activities. These include decentralization — the principle that planning must come from the bottom up; correlation—or the coordination of the activities of federal agencies; continuity—the recognition that planning is never finished but must continually be brought up to date.

Government reorganization

A second forum topic was governmental reorganization. Joseph P. Harris,



FAIR BUILDING BUILT INSIDE OUT

INTENDED to show the uses of steel, the exhibit building of the United States Steel Corp. at the New York World's Fair is so designed that its major structural members are exposed to view. Ten arch trusses, together with supplementary steel, support the dome of the building, while the central portion of the mezzanine floor inside is hung from the trusses by 2-in. rods.

The dome itself is of wood, to which flat sheets of stainless steel are nailed, horizontal S-joints in the sheets concealing the nailing. Vertical joints are covered by stainless steel battens. Placing of the stainless steel is shown above as it neared completion.

Corrugated stainless steel will be used as covering for the curved vertical walls which flank the main entrance. These walls are concealed in the picture by tarpaulins necessitated by winter stuccoing operations on the soffit of the main balcony. The walls of the circular main hall inside on the first floor will be of polished blue steel.

Construction of this building is one of eleven jobs being carried out by the George A. Fuller Co. at the Fair; L. F. Booth is superintendent. The building was designed in the office of Walter E. Teague; York & Sawyer are the architects and H. G. Balcom Associates are consulting engineers.

of the President's Committee on Administrative Management, defended last year's reorganization bill. The measure, he said, suffered from a "campaign of misrepresentation" and the label of dictatorship. In fact, he said, it was a carefully prepared program that would have resulted in more efficiency in administration without adding to the powers of the President or detracting from those of Congress.

Economics of the professions

Viewpoints of the kindred professions of teaching, the law, and architecture were voiced by George F. Zook, president of the American Council on Education, William C. Van Vleck, dean of the law school at George Washington University, and Francis P. Sullivan, chairman of the American Institute of Architect's committee on interprofessional relations.

Zook entered a plea for more cultural subjects in the engineering curriculum, even if this means lengthening the course. He pointed out that both medical and law students must now have two years of pre-professional college training.

Van Vleck stated that the present trend toward socialization of the professions is an effort on the part of the public to assure itself of necessary services at a price it can afford to pay. He also described the efforts of the legal profession to establish minimum educational standards.

Sullivan reviewed the economic problems of the architectural profession during the depression and advocated advance planning of public building construction programs to meet similar emergencies in the future.

Business session

Aside from the reports of the council's standing committees, the main topic of discussion at the business session was the body's financial status. President William McClellan pointed out forcefully that, although the staff is still hampered by a depression budget, it is having thrust upon it a steadily growing volume of work that cannot be avoided without damaging the engineers' standing in society. This work, he declared, must be done. If the present council mechanism proves unequal to the task, either from lack of support or otherwise, the task must be assumed by some other body.

The suggestion was made that council augment its income by setting up individual memberships, but action on this proposal was deferred.

Carroll O. Bickelhaupt and John S. Dodds were reelected as vice-presidents, Leonard J. Fletcher as treasurer. No other officers' terms expired at this time.

TVA's Six Months Revenue Above Previous Year

Revenues of the Tennessee Valley Authority from the sale of power during the last six months of 1938 totaled $2,615,000, exceeding by more than $300,000 the revenues for the entire preceding twelve-month period, it was announced Jan. 17. This revenue came from the sale, since July 1, of 806,800,000 kw.-hr. of energy at an average price of 4.99 mills per kw.-hr. This compares with a 5.57 mills average during the preceding year, the difference arising from the introduction of service to the city of Knoxville and improved use characteristics of other customers.

• • •

Jones and Hageman Shifted by TVA

Barton M. Jones, for the past year and a half acting chief design engineer of the Tennessee Valley Authority, has been appointed consulting design engineer, while Harry A. Hageman, chief hydraulic engineer, has been made chief design engineer. Both appointments became effective Jan. 16.

Hageman, a graduate in mechanical engineering of Cornell University, was for more than twelve years chief hydraulic engineer for Stone & Webster before he joined the TVA staff. Earlier he had been mechanical engineer in charge of plant design and construction for the Bethlehem Shipbuilding Corp. In his new post he will be responsible for the preparation of designs and specifications for all dams, reservoirs, locks and power houses.

Jones, who in his new post will review general design and special features of the various projects as well as study the performance of equipment with an eye to future design, is a graduate of the University of California in mechanical and electrical engineering. He was construction engineer during the building of Norris dam.

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Senate Committee Would Cut WPA

(Continued from p. 35)

the nation. Through the same office, workers for whom private employment is not available should be assigned to a job on a work program. By the merging of organizations engaged in the same work, great savings can be effected in administration costs.

"Projects conducted by the Department of Public Works should be of a public nature. They may be let to contract or conducted on force account depending upon their nature."

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

Senator Wagner introduced on Jan. 12 a bill which would authorize the U. S. Housing Authority to loan an additional $800,000,000 to local housing authorities and would increase the total annual subsidy which it could contract to make to the local projects by $45,000,000. USHA has already actually or tentatively allocated all its present $28,000,000 subsidy and most of the $800,000,000 which it is now permitted to loan.

Consideration is being given by administration officials to a plan under which work on public projects will be suspended when costs of materials or labor rise beyond certain levels. The rise in the cost of these items would be taken as an indication that private industry is becoming sufficiently active for the government to withdraw from competition for men and materials.

Opposition to the abolition of tax-free securities is not as strong as had been anticipated. Apparently tax gathering officials in some of the states have looked ahead to a larger government debt. As the federal debt rises the interest of the states in maintaining tax-free securities is decreasing.

While exemption-elimination sentiment is stronger than at the last session of Congress, the chances still are against action. The finance committee of the Senate probably will recommend a constitutional amendment.

There Will be a Market in the Pacific Northwest for twice as much power as the Bonneville plant can produce by the time the plant is completed, Bonneville Administrator J. D. Ross states in his first annual report. Since 1933 there have been no new major installations in that section except the Skagit development of the city of Seattle. Ross says that 25 power districts have been organized in Washington comprising all the heavy-load districts in the state except Seattle, Tacoma, Yakima and Spokane. On completion of now authorized transmission lines, at least six of these districts will be in a position to take Bonneville power and will require 150,000 kw. in 1941. Two districts and six municipalities in Oregon have requested power amounting to 50,000 kw. by the same date—at which time these amounts will exceed the available plant capacity.

Sydney Williams Dies Panama Canal Builder

Moritz Kahn of the Detroit architectural firm dies suddenly

Sydney B. Williams, first chief of construction of the Bureau of Reclamation and engineer in charge of the Pacific Division of the Panama Canal work under General Goethals, died in Lexington, Va., Jan. 13 at the age of 74. A graduate of Virginia Military Institute, Williamson worked from 1886 to 1890 for several railroads in the Northwest and on municipal work in the South. In 1892 he entered federal service and established his first contact with General Goethals when he became principal assistant to Goethals on the Muscle Shoals Canal in the Tennessee River. With the exception of brief service in the Spanish American war, he was engaged on this work for the next eight years. He was then transferred to fortification work at Newport, R. I. where he stayed for four years, working with General Goethals in that work also.

After three years of private practice in New York and Baltimore, Williamson entered the service of the Isthmian Canal Commission at the request of General Goethals with the post of division engineer of the Pacific Division. In that capacity he had charge of the construction of the locks at Pedro, Miguel, and Miraflores as well as dredging of the Pacific entrance and construction of terminal docks there.

After five years on the canal, Williamson went to London in 1912 as principal assistant engineer for J. G. White Co., but two years later he was recalled to this country to become chief of construction for the Reclamation Service. In this post he was in full charge of the Denver offices and all field matters went through his hands to Washington. He resigned that post after two years to become consulting engineer for Guggenheim Bros., where he remained for the next eight years.

In 1924 Williamson opened consulting offices in Birmingham in association with his son. During this period he worked again with General Goethals as consultant for the port of Palm Beach.

Williamson's last work for the federal government was done as a member of the Interoceanic Canal Board to which he was appointed by President Hoover to report on the feasibility of the Nicaraguan Canal. He retired from the Board in 1935.

Moritz Kahn, engineer and vice president of the Detroit architectural firm of Albert Kahn, Inc., died on a train en route from Detroit to New York on Jan. 13 at the age of 58. Kahn, who was born in Luxembourg, was a graduate of the University of Michigan and began his engineering career in 1903 with the American Bridge Co. A year later he joined the Trussed Concrete Steel Co. and in 1905 was sent to England to manage a British branch of the firm. He stayed in London until 1923 when he joined his brother's architectural firm. In 1930, Kahn had charge of construction of the $30,000,000 Stalingrad tractor plant for the Soviet Government and he was also connected with construction of a considerable number of important industrial plants for automotive and other companies in Detroit.

Charles A. Morrow, 70, a member of the Baltimore construction firm of Morrow Bros. Inc., died in Baltimore Jan. 11. Morrow's firm had built many buildings in Baltimore as well as the

CONTRACTS AND CAPITAL

Engineering construction awards for the week, $55,489,000, are 16 per cent above the total for the corresponding week last year, but 54 per cent below the peak volume of last week.

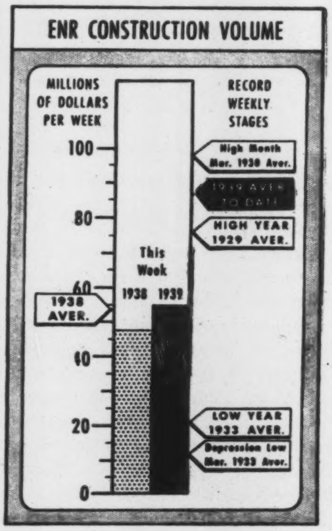
The construction total for the first 3 weeks of 1939, $262,210,000, is 88 per cent higher than the initial 3-week period last year.

The week's private construction is the highest since November 3, 1938, and 69 per cent above a week ago, but 30 per cent under a year ago. Public construction is 65 per cent below the record volume of the preceding week, but gains 64 per cent over the 1938 week.

In the classified construction groups, gains over last week are in commercial building and large-scale housing, and unclassified construction. Waterworks, sewerage, bridges, public buildings, earthwork and drainage, streets and roads, and unclassified report gains over their respective totals for the 1938 week.

New capital for construction purposes for the week, $22,504,000, is 54 per cent above the volume for the 1938 week. It is made up of $12,000,000 in corporate security issues, and $10,504,000 in state and municipal bonds. Sun Oil Company's $12,000,000 bond sale for construction in Marcus Hook, Pa., and Toledo, Ohio, is responsible for the corporate total.

New construction financing for three weeks of 1939, $57,654,000, is 85 per cent above the volume for the corresponding period in 1938.



CONTRACTS

(Thousands of dollars)

	Week Ending Jan. 20 1938	 Jan. 12 1939	 Jan. 19 1939
Federal	$2,338	$16,502	$3,369
State & Municipal	21,149	93,243	35,255
Total public...	$23,487	$109,745	$38,624
Total private..	24,182	9,981	16,865
TOTALS	$47,669	$119,726	$55,489

Cumulative
1939 ....(3 weeks).......$262,210
1938 ....(3 weeks).......$139,437

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 3 Wk.	 1939 3 Wk.
NON-FEDERAL	$31,066	$57,654
Corporate securities	1,990	17,645
State & Mun. bonds	25,935	31,971
R.E.A. loans......	......	8,038
R.F.C. loans......	2,000	......
PWA allotments..	1,141	....
FEDERAL	......	......
TOTAL CAPITAL.	$31,066	$57,654

FHA MORTGAGES

	Week Ending Jan. 15 1938	 Jan. 7 1939	 Jan. 14 1939
Selected for appraisal	$6,531	$13,389	$16,767*

Cumulative
1939 ......(2 weeks)......$30,156*
1938 ......(3 weeks)......$17,858

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Jan....	234.72	112.83
Building Cost	Jan.....	196.24	105.99
Volume	Dec....	249	109

Nebraska State Capitol at Lincoln and the Ford plant at Cleveland.

Frank C. Seehusen, for the past five years a special engineer with the PWA at Washington, died there last month at the age of 48. Before joining PWA, Seehusen practiced in New York for some years, specializing in steam and hydraulic power engineering.

Henry R. Leonard who retired in 1928 as chief engineer of bridges and buildings for the Pennsylvania R. R., died in Wayne, Pa., Jan. 11 at the age of 81. Leonard's first engineering work was in the office of the city engineer of Boston, where he stayed for nine years. In 1883 he became engineer for the Philadelphia Bridge Works and later practiced as a member of the Philadelphia firm of Leonard, Foley & Co. He spent a year as contracting engineer with the American Bridge Co. and in 1902 he joined the Pennsylvania as engineer of bridges. His title was changed four years later to engineer of bridges and buildings.

James Porter, formerly a member of the engineering staff of the city of Vancouver, B.C., died there recently at the age of 75. A native of Ireland, Porter taught for a short time at Columbia College in New Westminster, later joined the engineering staff of the old South Vancouver municipality and fifteen years ago entered the service of the city of Vancouver.

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Vermont Attacks Flood Control Plan

(*Continued from p.* 35)

the federal government of basic rights which belong to the people in the state."

1938 flood control act

Besides providing that the federal government assume all the cost of flood control reservoir projects, the flood control act passed by Congress last year authorized the Secretary of War to acquire any land needed for flood control "notwithstanding any restrictions, limitations or requirements of prior consent provided by any other act."

Federal plans for the Connecticut River call for construction of a dam on the Ompompanoosuc River at Union Village, Vt. Negotiations have been in progress since last October between the War Department, Governor Aiken, and the Vermont Board of Public Works to work out a method of procedure. The plans were embodied in a contract which was to have been made between the state government and the United States War Department.

On Jan. 5, however, Secretary of War Woodring wrote to Aiken that he would be glad to accept the state's suggestion that land be acquired through the State Board of Public Works but that since "the provisions in the state statutes appear to conflict in no way with . . . the flood control act . . . I do not feel that it will be necessary to complete the draft of formal agreement . . ."

The governor thereupon asked the state legislature to petition that Congress order the contract completed and also repeal the provision of the flood control act making state consent unnecessary and also to appropriate money by which the governor could oppose in the courts the federal government's position. The legislature appropriated $67,500 for this purpose and made the petitions which the governor had requested.

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Beach Preservation Group Reports More Study Needed

Meeting in Washington Jan. 11, the American Shore and Beach Preservation Association was told by J. Spencer Smith, chairman of the New Jersey Commerce and Navigation Board, who was reelected chairman of the association, that much more observation and study is needed of the effects of opening and closing inlets. It was pointed out that observations made during the New England hurricane will be of particular value.

Rear Admiral L. O. Colbert, director of the United States Coast and Geodetic Survey, said the hurricane had emphasized the need for more primary tidal observation stations. Tide levels during the hurricane exceeded all records at a number of points.

President Smith pointed out that studies of shore events are now so coordinated that more valuable conclusions are being reached in a single year than formerly was possible in a decade.

Major General Julian L. Schley, Chief of Engineers, U. S. Army, called attention to the fact that cost is one of the most important factors in stabilizing beaches. He said that although local accretion sometimes occurs in the shore line, yet the net result over a long period of years has been a gain for the sea. Too often, he said, the value of protective works is not realized until after storms have taken a toll many times greater than the cost of the protection that could have been provided.

In addition to President Smith other officers were reelected as follows: George Hjelte, Los Angeles, vice-president, and Frank D. Holmes, Jr., Trenton, secretary-treasurer.

Chicago Subway Plan Changed Again

Changes in grade avoid interference with subsurface structures

Grade lines established in the original plan for the Chicago subway system have been modified to avoid interference with existing and proposed underground structures. The plans for the Chicago subway were drawn very hurriedly in order to meet the PWA deadline of Jan. 1 for award of contracts; the cross section of the tubes has already been modified (*ENR*, Jan. 12, 1939, p. 1). Subway officials expect that more changes will be made as studies progress.

Stations moved

The most important present change is a shift in the location of the stations along State St. from the street intersections to the centers of the blocks. This will lessen interference with utilities and with cross street traffic during construction and will also facilitate future construction of east and west subways above the tube now under construction. With the latter object in mind, the grade of the State St. track level has been changed from 39 ft. below street level to 44 ft.

At the Lake St. River crossing, the original design which calls for a double track tube between the piers of the existing bridge which carries the elevated has been modified so that single tracks will be placed one above the other. This will avoid the necessity of rebuilding the bridge piers. East of the bridge, the grade has been lowered to avoid interference with the old LaSalle St. tunnel stub. A station will be located at Lake and La Salle Sts. with the platform 47 ft. below street level.

• • •

Credit for Fast Pace On Whitestone Bridge

In the text accompanying the series of news pictures on the Whitestone Bridge (*ENR* Jan. 12, 1939, p. 60) some important omissions were made in the paragraph crediting various individuals and firms for the fast pace being made on this structure. Thus, it should have been noted that Leon S. Moisseiff, as consultant to the Triborough Bridge Authority, had much to do with the unusual design; that Moran, Proctor & Freeman, consulting engineers, designed the foundations and furnished general construction supervision on them; and that H. W. Hudson is engineer of construction for Madigan-Hyland, the supervising engineers.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Applied Soil Mechanics

Sir: There is apparent at times in your editorial and other paragraphs a tendency to levity which is somewhat startling in a staid and soberminded technical journal. Nevertheless, we may take this as a sign of a healthy molecular reaction in a profession the responsibilities of which unavoidably tend to make its members soberminded also. I once knew a Deputy New York State Engineer who told me he was going to change to a business career because he found he was getting too serious a look upon his face. So he made the change. But I have often wondered what he looks like now, since business has been transmogrified into a depression.

Encouraged by this tendency, I submit a memorandum on the latest scientific foster child of the profession, namely, soil mechanics, which may be of interest to students and unmarried members. Going down a forest trail the other day I observed in the moist sand what appeared to be the spoor of some predatory animal. Each footprint consisted of a deep hole with a faint distorted-ellipse mark in front. The longitudinal spacing was 1 ft. $1\frac{3}{16}$ ins. c. to c. Evidently a female of our species had but lately passed that way. The instincts of the engineer were aroused. They impelled me to investigate the visibly-outrageous unit pressures the creature had carelessly sported. Carefully measuring the prints and allowing for the fact that every woman wears shoes not less than two sizes too small for her foot, I judged the body weight to have been about 130 lb. Assigning therefore such constants, ephemerals and imponderables as seemed to fit the case, I applied them to the various advocated equations of soil mechanics. Each equation gave me a different result. But the imponderables alone, such as the incrementing tangential support from the flare of the heel, the pressure distribution when the tootsie came to full bearing, i.e., were enough to stump any soil mechanician. So I fell back on crude rule of thumb.

130 lb. x 0.214 sq.in. (the base area of the heel) = say 615 lb. per sq. in., or about 44 tons per sq. ft. (I hope that's right).

This would be the initial pressure on first base, so to speak. And that on soft sand! No wonder our pioneer forefathers had to provide wooden sidewalks in their towns and villages as soon as they were able, to be followed, as the unit pressures increased, by others of stone and concrete. In fact, when in 1893 I first visited Boston, then the center of the shoe industry, all the downtown sidewalks were of thick slabs of granite.

Having secured this damning evidence, I confronted a member of the Opposition with it. She merely remarked: "Don't be silly!"

Thus do we see the sacred principles of soil mechanics literally trodden under foot contemptuously and on every side by the fair sex; even—it gives one quite a nasty turn to think of it—even by the wives and daughters of the soil mechanicians themselves. Like Herr Hitler with the plastic Mr. Chamberlain, they seem to get away with anything they want. But if any bachelor engineer may be inclined after reading the foregoing to take a gloomy view of the situation, I commend to him the aphorism of Epictetus: "Seek not to have things happen as you choose, but choose them rather to happen as they do, and so shall you live in tranquility."

David A. Watt
St. Petersburg, Fla. Dec. 17, 1938.

Highway Design

Sir: A number of highway designers who attended the Highway Research Board meetings last week have read your interesting comments and editorials on the meetings as published in *Engineering News-Record*, Dec. 8, p. 718, 722. Recently they questioned me as to your conclusion that design subjects were less prominent at those meetings than formerly.

According to the Highway Research Board the subject of design as handled by its department of design includes geometric characteristics such as sight distance, curvature, intersections, gradients, cross section, roadside development, number and width of traffic lanes and also structural characteristics such as rigid type surfaces, flexible type surfaces, pavement joints, load distribution through surfaces to subgrade and related structural subjects except soil investigation, which is handled by the soil department of the board. You may also be interested to know that the special committee on administrative design policies of the American Association of State Highway Officials considers the subjects of highway classification, sight distance and intersections to be of first importance to those responsible for highway design.

In view of the foregoing we have concluded that your reference to the less prominent position of design in the Highway Research Board program applies only to the structural design of the roadway pavement and not to the proper and broader concept, which includes also the dimensional characteristics of the entire highway.

C. N. Conner
Chairman, Department of Design,
Highway Research Board
Washington, D. C., Dec. 22, 1938

The editorial comment in question was directed only to structural design. Attention to geometric design and to the many related matters is expected to increase, as Mr. Connor states.—Editor.

Leaky Brick Walls

Sir: May we compliment you and Mr. A. B. MacMillan on the publication (*ENR* Dec. 1, 1938, p. 707) of one of the most illuminating and convincing statements concerning leaky brick walls that we have seen?

We know of only one other measure that might be taken, and very frequently is, to increase the likelihood of leakage: The use of as wet a mortar mix as can be handled, which results in excessive initial shrinkage and can be relied on to break the bond between mortar and brick, even if the mechanic is conscientious in filling the head joints.

E. L. McFalls,
The Master Builders Company
Cleveland, Ohio, Dec. 23, 1938

Sir: The timely and interesting article by A. B. MacMillan entitled, "How to Build Leaky Brick Walls with Good Materials" (*ENR* Dec. 1, 1938, p. 707), directs attention to the most important of the factors which govern the resistance of masonry walls to penetration by rain. So much publicity has been given to features of less importance that specification writers and builders are sometimes led to concentrate their attention on them. The results of laboratory investigations and of experience indicate that faulty flashings and poorly filled mortar joints are largely responsible for leaks in masonry walls. The effects of qualities of workmanship and mortar and of the condition of brick when laid are illustrated in the report of the National Bureau of Standards, BMS-7, "Water Permeability of Masonry Walls," obtainable from the Superintendent of Documents, Washington, D. C., for 10 cents.

The author's definite statements regarding the coefficients of thermal expansion of masonry materials and the effects of differences in the expansiveness of adjacent materials on the tendency for walls to leak seemingly are not entirely justified by the information available. The readily available data in the literature indicate that the coefficients of thermal expansion of masonry materials usually are within the following limits:

	Millionths per deg. F
Clay brick	2.0 to 4.2
Mortar	4.5 to 6.5
Brick masonry	2.5 to 4.5
Concrete	4.0 to 6.0
Limestone:	
Oolitic, Bedford, Ind.	5.0
Mt. Vernon, Ky.	4.6
Oolitic, Bath, England	2.3

The values for brick masonry are estimated from data on brick and mortar. The others were obtained largely from the International Critical Tables, "A Summary of Investigations of Volume Changes in Cements, Mortars and Concretes Produced by Causes other than Stress," by Raymond E. Davis, *Proceedings*, American Society for Testing Materials, part I, Vol. 30, p. 668, 1930, "Report of Tests of Metals . . . ," Watertown Arsenal, June 30, 1896, p. 367, and National Bureau of Standards Research Paper No. 321, "Volume Changes in Brick Masonry Materials."

The values in the foregoing table show a wide range for brick masonry and concrete, indicating that the differences between the coefficients of thermal expansion of concrete and brick masonry may be negligibly small. Moreover, differential movements between contiguous portions of structures may occur, even if they have similar properties. For example, copings on walls, window sills, and other horizontal members which are exposed more fully than the body of the wall tend to undergo larger and more rapid changes in temperature. In addition, as the magnitude of changes in moisture content depend on the exposure, it seems likely that the combined effects of movements caused by temperature and moisture frequently may be as great as those resulting from differences in coefficients of thermal expansion.

Nevertheless, and regardless of the cause and magnitude of differential movements between parts of a structure, Mr. MacMillan, by describing how to build leaky brick walls, has shown how to prevent serious leakage through openings caused by these movements, and has concentrated attention on the essential features of leakproof masonry.

D. E. Parsons
Chief, Masonry Construction Section
National Bureau of Standards
Washington, D. C.

Lessons Learned at Dayton

Sir: Commendation is due the superintendent of the Dayton, Ohio, Sewage Treatment Plant for his quick and frank report of the unfortunate gas explosion which occurred at that plant on Nov. 12. Since the accident was reported to have been caused by a change or "improvement" by the operators in the provisions made by the designing engineers, we might naturally expect a reluctance on the part of the administrative officers to release such information. Evidently the adage "Man marks when he hits but fails to mark when he misses" did not hold true in this instance. Yet, as you imply in your editorial, "The Dayton Explosion," *ENR*, Dec. 1, p. 695, paradoxically, we progress more by avoiding former failures than by repeating former successes.

In this instance, the mistake of the operating personnel in changing what might seem but an unimportant provision of the designing engineers, presumably without advice thereto from the engineers, resulted in an accident which by mere chance was not fatal.

Among other important lessons to be derived from this case is that pertaining to the matter of supervisory service which should be rendered by engineers after their designs are placed into operation. There has been a trend in that direction in some recent engineering contracts for the design of sanitation works. Such contracts occasionally contain "operating" or "supervisory operation" clauses. The trend, however, is but slight, the greatest drawback being the owner's non-appreciation of and the difficulty of showing him—in so many figures—the value of such services.

Absence of "supervisory operation" by the designing engineers does not always, and need not necessarily result in failures of the spectacular type, such as explosions. Sometimes it may be at the expense of dollars, or at the expense of quality. These items become lost among many others and are therefore not evident. Obviously, in the design of a modern sewage works—and the same may be said of any process, industrial as well as sewage treatment—the designing engineer has before him distinct operating ideas and procedure for which he provides certain machinery, valves, controls, safety devices, etc. Most people experienced in the art can take over works of that kind and understand their function sufficiently for perfunctory operation. They are naturally not in a position to know, without the expense of time (which means, in effect, low operating results and high cost during such time) the special ideas of operation provided for in the design which are intended to make a particular plant perhaps more efficient, safer and less expensive to operate than a similar plant elsewhere. Sometimes, the design idea or item involved may be an "unimportant" or an inexpensive detail, as for example the flame traps and gas domes at the Dayton plant. An understanding of their purpose and function, however, may sometimes prove as important as an understanding of the most expensive item in the plant.

In the course of the "supervisory operation," the ideas behind the design will be transferred from designer to operator.

M. H. Klegerman,
Associate, Alexander Potter
Consulting Engineer
New York, N. Y., Dec. 6, 1938

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Editorial Offices at 330 West 42nd Street, New York
JANUARY 19, 1939

JUST as the year closed flood-control work in New England was largely shut down and no explanation was forthcoming from the army engineers. Last week the reason became apparent; the Governor of Vermont made known that he had challenged the federal government's right to enter his state to build a flood-control project without consent of the state. In this reassertion of states rights Vermont has since been joined by other states. Thus states rights, which in themselves are abstract questions having little bearing on construction, have become a matter of concern to construction men because a controversy centering around them may hold up projects that would provide needed work. And so it may be of interest to note how closely engineers' and contractors' jobs are tied to questions of federal policy which may appear far removed from the job itself. In this case, for example, the basic cause of the delay is wholly unrelated to federal policy on the matter of flood control. It finds its origin in the desire on the part of a few influential people in Washington to center the control of practically all water-power resources in the federal government. Unquestioned assertion of federal right to build flood-control dams on non-navigable streams is a sure and easy step in that direction, hence the insertion of a provision in the flood-control act of last year permitting the federal government to take flood reservoir land by condemnation.

Sewage Disposal Statistics

WITH THIS ISSUE we publish the results of a nation-wide inventory of sewage disposal facilities which is unique in that it brings widely scattered data together for the first time. And as it is patterned after a similar study made by *Engineering News-Record* in 1935, it furnishes a factual measure of progress and trends in these last three years of rapid advance. The data for each state, compiled under fifty separate categories, make it possible to get an accurate and comprehensive picture of the status and type of sewerage facilities in the United States. Compilation of this summary of official data would not have been possible without the aid of the 48 state sanitary engineers and directors of health who so generously supplied information and then painstakingly checked and rechecked our tabulations to insure their accuracy.

In High Gear

PERHAPS the most gratifying trend exhibited by the *Engineering News-Record* survey of sewage disposal is the rapid rate at which treatment facilities are being extended. More than half the urban population is now provided with sewage treatment —this represents a gain of 52 per cent in three years! Even more gratifying should be the assurance, based on the number of new plants being projected, that this rate of increase will not be diminished. And in this connection it should be mentioned that in the past year contracts for sewerage work reached an all-time high—over $136,000,000 as compared with the previous high of $121,000,000 in 1936. There is a lot more work to be done before facilities have been provided in accordance with needs, but no one can feel discouraged with the progress made since 1935.

Prefabrication and Public Opinion

SETTLEMENT OF A STRIKE of carpenters on the Queensbridge public housing job in New York last week did nothing to settle the cause of the strike, namely whether the construction industry is to be allowed to make its best contribution to low-cost housing. The carpenters tied up the job because the contractor used prefabricated beam and column forms, contending that stock sizes of plywood should be purchased and fashioned into forms on the site. The situation is not unprecedented. Every study of methods to reduce the high cost of building has concluded that substitution of shop fabrication for job craftsmanship offers an outstanding opportunity for economies. But every attempt to practice prefabrication is immediately batted down by union labor. Thus prefabrication is reduced to a nice theory, and theory it must remain until labor can be convinced that prefabrication will make more jobs than it will destroy. It may well be that public opinion, which forces so many reforms, may be the only agency that can win this conviction. In this respect the Queensbridge case, it may be noted, leaves labor leaders in a vulnerable position. For this is public housing upon which the federal government has lavished subsidy and upon which designers have worried and sweat to make the cost low. By a strike, and by insisting upon costly methods, union labor acts to obstruct the efforts of the other parties to the low-cost housing program. Public opinion can hardly accept such a situation for long.

Professional Ideals

HARD FACT directs the activities of the engineer at all times, as everyone knows, and the needs of the moment often submerge knowledge of the truth that his place in the world is in last analysis determined by his service to human society. It is therefore helpful to have a leading thinker among engineers lay stress on the public-service ideal as guiding principle of professional thought and action. Vannevar Bush, president of the Carnegie Institution of Washington, spoke a timely word in reaffirming this ideal before the American Engineering Council last week.

Dr. Bush's message addressed itself to the engineer as an individual and to his technical societies even more than to the Council. He reminded his hearers that there has been no true profession that has not guarded the common weal, and that "a profession exists only as the people allow it to maintain its prerogatives by reason of confidence in its integrity and belief in its general beneficence".

For the individual engineer the significance of the ideal of ministration is plain. Without its vitalizing influence much of his work merges into the routine craftsmanship of skilled labor rather than to bear the impress of professional character and quality. Whether in setting a survey stake or detailing a structural joint, his thought and hand are most truly guided by the trust obligation of ministering to his fellow men. So long as the engineer acknowledges this guidance as paramount he will live up to his best possibilities and will be part of a true and worthy professional body.

In a like sense the public obligation is the essential bond of the engineering society. Activities directed to the interests of its members alone, useful though they can be, hardly lift the society above the level of a craft union or the continuation trade-school. Discussions of ingenious analysis, of stress proportioning or of registration laws remain subject to the primary criterion of public interest and human progress. No national society can hope for lasting strength and influence unless ministration to the public is a living part of its constitution and order of business.

Fortunately there is no lack of recognition of the public-ministry ideal among engineers. Consciousness of the profession's responsibility is a very real thing and forms the daily inspiration of engineering work both small and large. Yet, lest we forget amid the press of daily practical needs, the surpassing importance of the professional ideal warrants the reemphasis given to it by Dr. Bush and commends it anew to the notice of all, to the end that it may become the ever-present guide of the engineering profession.

No Benefit Evident

RECENTLY ORGANIZED in New York City is the Supervising Professional Engineers Union which is now actively engaged in seeking members. From the limited knowledge of its objectives that can be obtained from its organizers, this union does not seek to bring together all engineering employees engaged in building inspecting work for collective action on matters of pay and working conditions. Rather, it seeks only a sufficient number of licensed engineers to provide one or more inspectors for all important building jobs in New York City and when that number has been attained to force their employment as inspectors at $125 a week through an arrangement with the building trades unions whereby the latter unions will refuse to work on jobs not employing S.P.E.U. inspectors.

The union proposes to have its inspectors pass not only upon workmanship and working conditions but also upon design and specifications, being able to overrule the owner, architect, or builder—even the city's own building inspectors—by the expedient of calling a strike to enforce their demands. The disorganizing effects of such a dictatorship are apparent, while the beneficial effec are quite obscure.

The record of the union and its objectives is fragmentary; little is down in black and white except its blind advertisement in the help-wanted columns of a New York paper and the guarded reply of its president to those who answer the advertisement which implies that those who join quickly will be able to obtain one of 150 jobs at $125 a week which the union has available. From this record only one conclusion can be drawn; the Supervising Professional Engineers Union should be repudiated by the profession whose name it takes so lightly and by the trade unions which it seeks to use as stepping stones to attain what now appear to be purely selfish ends. If there are facts which would invalidate these conclusions the responsible engineers in the union should bring them into the light.

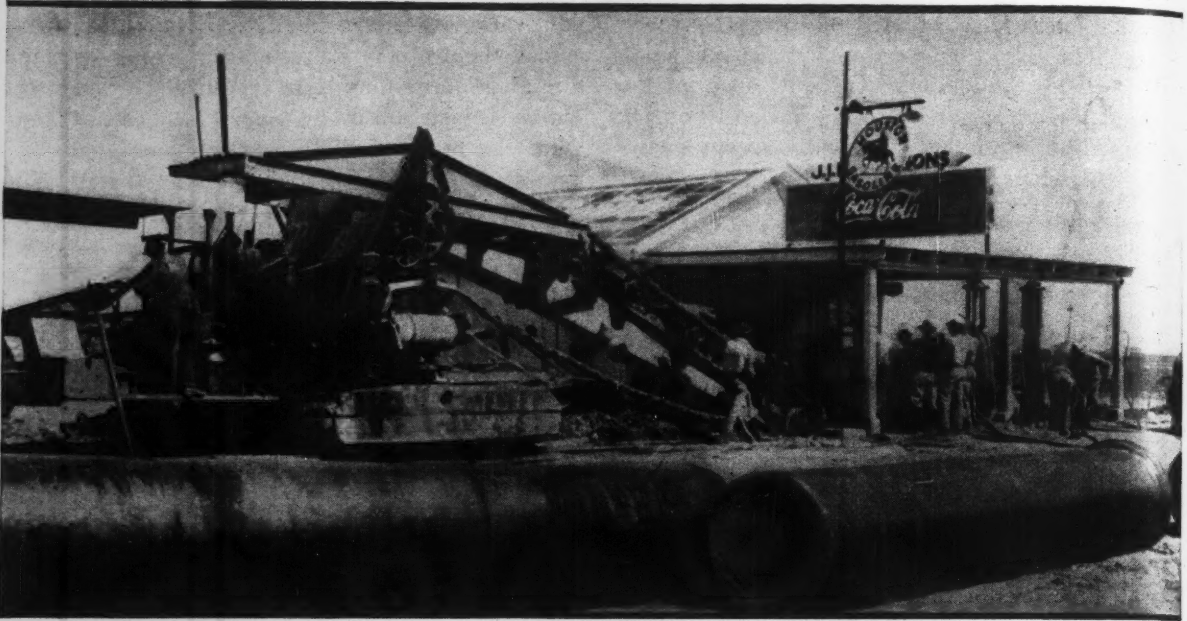

FIG. I. WORKING THE TRENCHER IN CLOSE QUARTERS TO REDUCE THE AMOUNT OF HAND DIGGING

New Water Line for Corpus Christi

***Contents in Brief**—Due to its rapid growth in population, Corpus Christi, Texas, has had to enlarge its water supply system by adding a 30-in pressure line 16 miles long connecting the city with the filter plant. Cement-lined cast-iron pipe was used with cement joints. This type of pipe was chosen because of its anticipated freedom from progressive loss of carrying capacity. Trenching through gas and oil fields with many buried pipe lines introduced an unusual problem for the contractor which was met by the use of a small pilot ditcher.*

A MAJOR PROBLEM placed before the engineering department of the city of Corpus Christi, Texas, by its growth in population from 28,000 to 60,000 in seven years was that of keeping the city supplied with water. Fortunately, a plentful supply of raw water is available on the Neuces River, 35 miles inland, where the city built an impounding reservoir in 1930. Thus the problem was reduced to that of bringing an enlarged supply to the city and distributing it at adequate pressures. Adding to the filtration plant also was a factor.

Both the plans for doubling the capacity of the filtration plant, bringing it up to 15 m.g.d., and the method of expanding the distribution system were described briefly in *ENR* Aug. 4, 1938, p. 142. This article relates to the new supply line and its speedy construction.

Water from the 66,000 acre-ft. capacity impounding reservoir flows down the river to Calallen, 16 miles from the city, where a weir forms a pool from which water is pumped first to the filtration plant and then to the supply line to the city. Five pumps having a capacity of 9 m.g.d. formerly served the city through a 20-in. tar-coated cast-iron line laid in 1915 when the population was 10,000. Tests on this 23-yr. old line indicated that it had a friction factor of $C = 105$, equal to an age of 15 yr. based on Hazen & Williams' $C = 130$ for new pipe. The pumps are 12 ft. above Gulf level and the surface of the storage tanks at the city is at El. 159. Static and friction head is 405 ft. Records show that 5.5 m.g.d. was the maximum capacity of the line, less than 100 gal. per capita for the present population; and that capacity was obtained only at excessive pumping costs.

Heavy restrictions on water use were necessary under these conditions, but a 10-m.g. reservoir at the city completed last March has helped to alleviate the situation.

A capacity of 10 m.g.d. for the supply line was set as desirable by engineers engaged by the city to study the problem. With the pumping rate at Calallen kept uniform the new storage reservoir at the city could be filled during periods of off-peak demand, thus building up a reserve for peak-load periods. A 30-in. pressure line with a friction factor between 135 and 155 was deemed satisfactory.

Cement-lined cast-iron pipe was chosen because of the small decrease in value of C due to age in such pipe (See A.W.W.A. *Journal* Sept. 1936). The engineers considered that a value of $C = 150$ could be assumed for a considerable period of years. In their studies the extra cost of the ¼-in. lining and the decreased area were weighed against the increased carrying capacity during the expected life of the pipe.

Thickness of the 30-in. spun pipe was determined from expected trench loadings following the method outlined in *Bulletin 96,* Iowa State College. Trench specifications called for a trench 12 in. wider than the pipe diameter with backfill brought up uniformly in 6-in. compacted layers to the springline, then in 12-in. layers to 12 in. above the top of the pipe. No tamping was called for above that joint.

Bids were asked on ⅜-in. steel pipe with a spun tar enamel, but the bids exceeded those for cast iron. Valve specifications called for double-disk, iron body, bronze mounted type to meet the tentative specifications of the A.W.W.A.

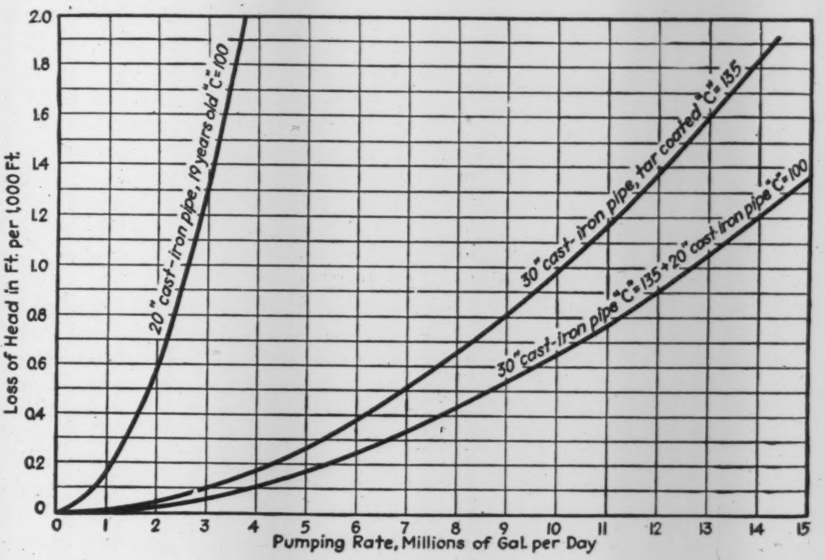

Fig. 3. Friction head at different pumping rates in the new and old lines.

Cement lining and joints

The novelty of the project is in the use of cement lining and cement joints. The lining was put in at the pipe plant, mortar being fed into the pipe while it was rotated and screeded into place. Special castings were lined by hand.

Two methods of cutting the pipe were employed, a lathe-type cutter and hand cutting, using a cold chisel and hammer. These methods were found better than the wheel-type cutter as the latter forms a pressure ridge on the inner surface of the cast iron which tends to shatter and break the lining for some distance back. In cutting with a chisel the first round is a light cut largely to mark the line. The second round is cut with heavy sledge blows. During this round the cement lining will crack at the line of the cut but does not shatter. The third cut is also made with heavy blows. Usually the pipe will separate before the entire circumference has been covered. The lining breaks surprisingly close to the line cut, seldom chipping back as much as ¾-in.

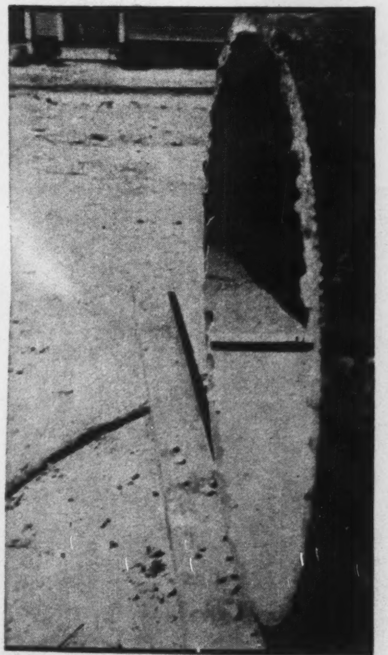

Fig. 2. Cement lined pipe cut with sledge and chisel in three operations chips back less than ¾ in.

Cement joints were chosen because of good performance elsewhere, because of a possible saving of $29,000 over lead in the bids, and a chance to save enough to pay for the $1,000 excess of cement-lined over tar-coated pipe. Tests made prior to construction, making joints with gun-type equipment, resulted in failure. The joint could not be filled and calked tight and considerable leakage resulted. However, on a 20-in. pipe, using cement calked by hand, pressures up to 125 lb. failed to affect the joint. At this pressure the brazed caps on the ends of the pipe blew out.

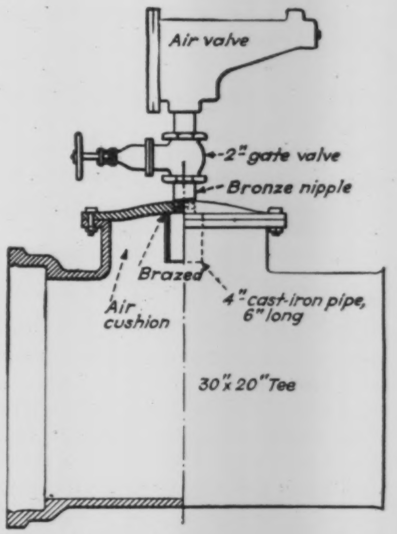

Fig. 4. Air vents were mounted in large tees to trap air being carried along in the pipe.

Pipe line construction

A 48-in. trench was excavated by a trencher with 42-in. buckets equipped with side cutters. The deepest cut was 10½ ft. and the average cover 4½ ft. At bell holes the cutter was dropped 1 ft. for a distance of 3 ft. Widening was done with air spades.

When the bottom of the trench had been hand dressed to grade, pipe was handled from the stock line into the trench by a crawler dragline with 45-ft. boom and wire sling. As the pipes were lowered into the trench and as a joint was seated a strand of ½-in. braided jute was placed between the spigot and bell, and the joint forced home as the pipe was being trued up for line. The spigots were centered in the bell by means of chisels used as wedges, following

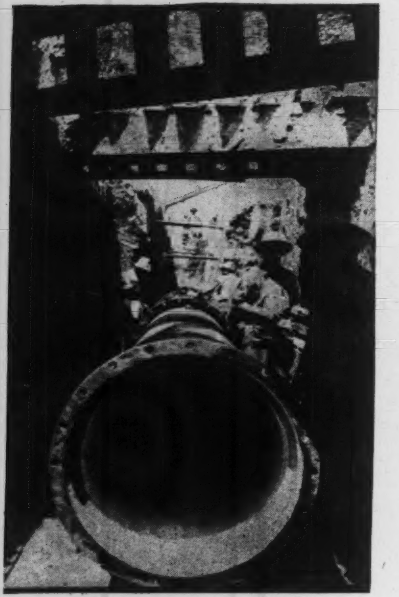

Fig. 5. Under a railroad, pipe of flanged-type was used.

which the jute was tightly calked. Pipe laying was kept 100 ft. ahead of the cement calking so as not to disturb the finished cement joints which were made by the following procedure.

Jointing procedure

A dry mixture of cement and water was used for the jointing, using only sufficient water to enable the mixture to be balled in the hand. This mortar was packed into the joint to half depth and calked with hammer and calking irons. As soon as the first round had been finished, the joint was filled and calked flush with the bell. The calking blows with the hammer were practically as heavy as if lead instead of cement were used for the joints.

Following the calking crews was a calking inspector, employed by the contractor, who checked the work on each joint and wiped a fillet of mortar or mud over the exposed joint to prevent rapid drying out of the water in the cement. The calking crew consisted of six men, four calkers working in pairs, a mortar mixer and the follow-up man. One sack of cement made five joints.

After the pipe had been laid a workman went through it pointing up the joints with mortar and removing debris.

Where leaks were found during line tests the cement joint was generally cut back for one-half the depth of the bell over the area showing seepage, after which the cut was filled with fresh cement and calked. During such work pressure was taken off the line but the pipe was not drained. This method proved effective.

Air valves

Air relief valves were installed at the summits of the new line using the design shown in Fig. 4. This type was developed as the result of experience on a recently built long line where the vents were tapped directly into the pipe barrel. In that line air was carried 20 ft. past the tap making it necessary to install a second tap at each summit to catch the entrained air.

Trenching difficulties

The new line passes through the Turkey Creek, Saxet and Corpus Christi oil and gas fields, and crosses 144 lines ranging in size from 1 to 14 in. and carrying pressures up to 1,000 lb. Although the highway department records show the location of practically every pipe line along the highway followed by the new water line the contractor, as a precaution against breaking unrecorded gas or oil lines, used a small trencher to cut an 8-in. pilot trench ahead of the regular trencher. This small trencher was equipped with an automatic trip which stopped it when any obstacle was encountered; as a result of this precaution only three small lines were cut, and none of these was under pressure.

Inspection

Shop inspection resulted in only 19 pipes being scrapped out of the 5,204 cast, or 1.1 per cent. In the field, as each section was completed up to a valve it was put under pressure and inspected for leaks. As leaks or seeping joints showed, pressure was taken off the line while the joints were recalked. A gradual and definite drop in leakage occurred over a period of 2 or 3 weeks. In July, 1938, a leakage of 1,000 gal. per mile per day or 33 gal. per inch per mile per day was recorded and more recent reports show further decreases.

The contractors, Brown & Root, Inc., of Houston and Austin, used 40 men, the crew consisting of the following: 2 trenchers, 2 backfillers, 6 calkers, 1 dragline operator, 2 pipe handlers, 3 pipe setters, 6 tampers, 6 bellhole diggers, 2 grade men, 1 batter-board man, 2 yarners, 1 mortar man, 2 levelers on right of way, 1 truck driver, 1 water boy, 1 night watchman and 1 foreman. The standard shift was 10 hr.

The job was completed May 12, 1938, five months after the work order was issued.

The work was carried out under the general direction of J. C. Bisset, city engineer. Myers, Noyes & Forrest, Dallas, were the consulting engineers, drawing the plans and specifications and supervising construction.

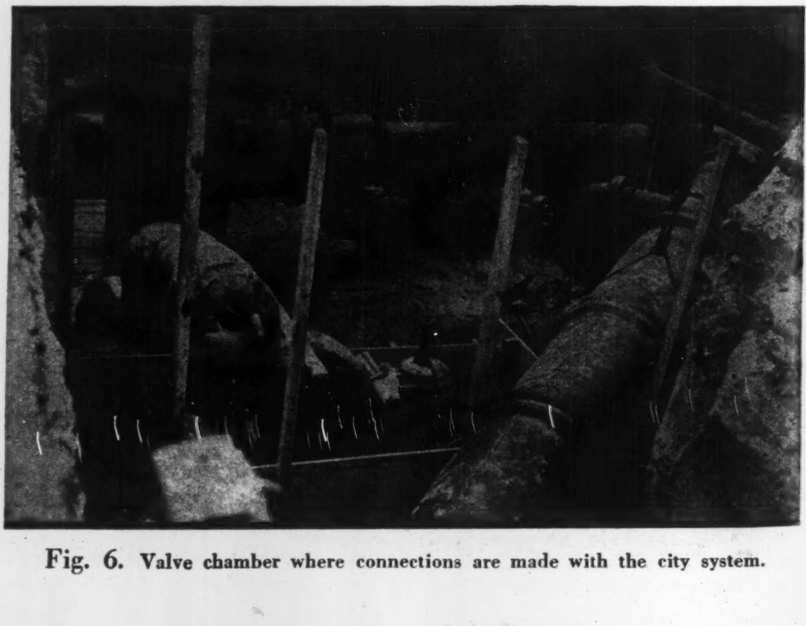

Fig. 6. Valve chamber where connections are made with the city system.

Well Planned Pier Welding

JOHN E. FAIGLE

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***Contents in Brief**—Five identical welded steel piers at Key West were built by a procession of crews each performing a separate set of operations and moving to the next pier. A nice problem of driving long rows of batter piles to line was solved by ingenious transit operation. Field welding of connections was simplified by performing all but final welds before steel erection. One pier a month was completed, including waits for low tides to weld final underwater connections.*

IN BUILDING five steel pile piers to replace a number of old teredo-riddled wood piers at the Key West, Fla., Naval Station, the division of the task into groups of operations by separate crews made possible a scheduling of the work that paid in speed and quality. But the work has another interest: The steelwork is virtually an all-welding operation and to a large extent was prewelded on shore before erection in the piers. Incidentally, as all the piles are batter piles, keeping the alignment accurate was a delicate task of instrumental control.

A view of one of the completed piers is shown by Fig. 1, and essential structural elements by Fig. 2. The piers extend diagonally out from a reinforced concrete retaining wall a distance of 330⅓ ft. on the long side, and about 5½ ft. less on the short side. The first pile bent is parallel to and about 3 ft. from the wall, while the remaining bents are perpendicular to the center line of the pier, and 12 ft. apart on centers. Each bent, except the first two inshore and the first outshore, consists of two steel H-section 10-in. bearing piles driven on 1:9 batter and one brace pile of the same section driven on alternate sides at adjacent bents on a 7:12 batter. The first two inboard bents consist of two bearing piles and the outboard bent of two bearing piles and two brace piles. Each bent is capped by a 21-in. 73-lb. I-beam, 21½ ft. long.

Pile alignment control

The piles were driven with a barge-mounted piledriver having leads with a transverse swing and a 2,600-lb. hammer. The problem of lining up the driver was somewhat unusual, due to the rise and fall in tide and to the batter of the piles.

Base lines perpendicular to the center lines of the piers were laid off on a road running behind the retaining wall. On these base lines two points were located on each side of the center line, one for the bearing and one for the brace piles, Fig. 3. The spacing of these points about the center line was made to equal the normal distance from a plane passed vertically through the center line of the pier, to planes passing respectively through the extended center lines of the bearing and brace piles, at an elevation 5 ft. above the finished deck level, which was decided on as a convenient height for an instrument. Short lengths of ¾-in. pipe were then imbedded in the roadway about these points to receive the legs of the tripod. These pipes were spaced so that when the transit was set up and leveled the desired height of instrument was either attained or resulted after a minimum adjustment.

To line up the piledriver it was only necessary to invert the instrument and sight at a backsight with points similarly spaced about the extended center line of the pier, lock the horizontal motions, reverse the instrument and level it. When the center line of the leads at any point was made to coincide with the line of sight of the instrument, the barge was in correct lateral position for driving. The piles were driven from 6 to 8 ft. into the native coral rock.

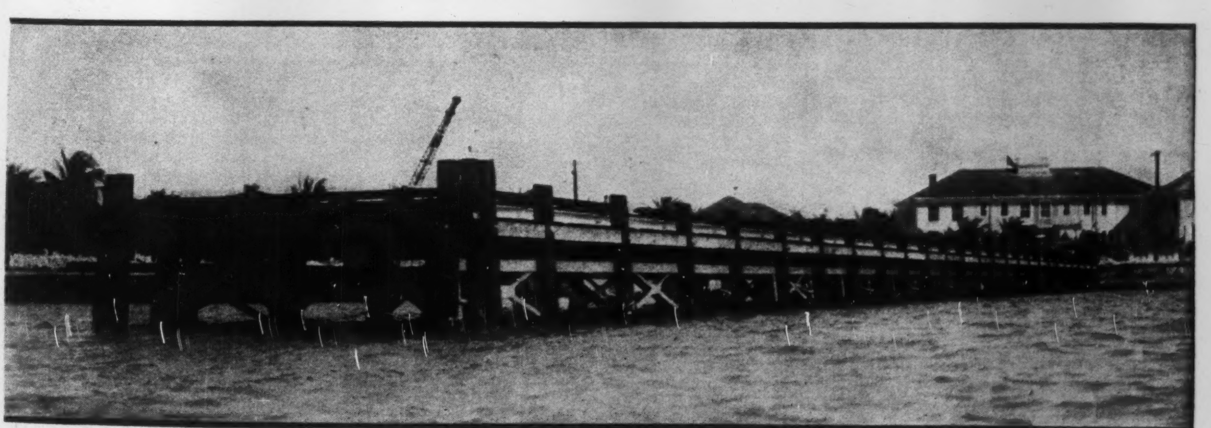

Fig. 1. One of five steel-pile piers at the Naval Station at Key West, Fla., built almost entirely as an all-welded operation.

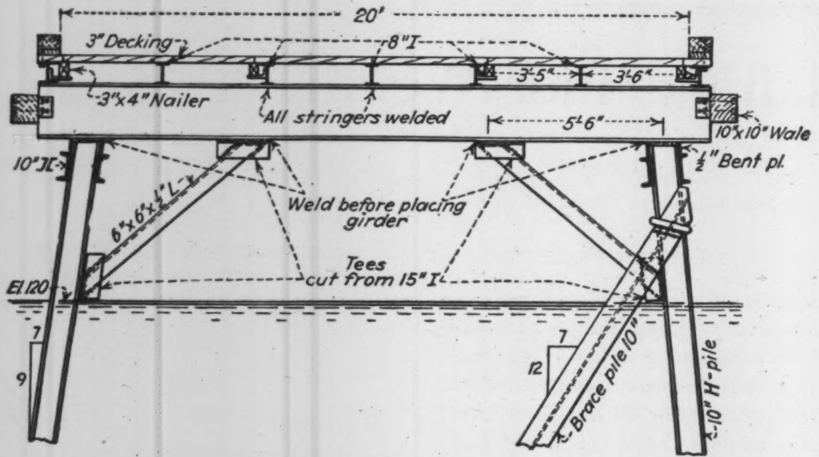

Fig. 2. **Plans for the Key West piers introduced a nice problem in driving batter piles to line; the welded connections are indicated by notes or symbols.**

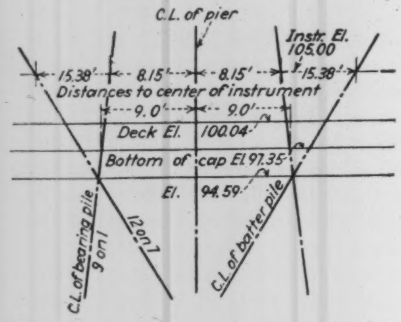

Fig. 3. **Method of lining up piles and deck steel by transit.**

The resulting alignment after driving was very satisfactory; in some cases the piles did not have to be pulled more than $\frac{1}{4}$ in.

Piles welded and capped

As previously stated, since five piers were to be constructed the operations were carried on by several units, each passing on to the next pier when its particular job was finished.

A primary steel erection gang aligned the piling after it was driven with the help of an instrument man, and secured the brace piles to the bearing piles with U-clamps. The brace piles were then marked and cut off by a burner to allow the channel wales to be temporarily clamped in place and then tack-welded. After this the caps, to which the bent plates had already been welded ashore, were placed, clamped and tack-welded. The necessary slight adjustment in elevation of the caps was made by small steel wedges.

In the next operation the caps were checked for alignment and where necessary the U-clamps holding the brace piles to the bearing piles were loosened and the bents re-aligned. The brace piles were then tack-welded to the bearing piles. This completed the work of the primary steel erection gang, which moved on to the next pier.

Bracing the next step

The secondary steel erection gang, following close behind the primary erection gang, erected the knee and longitudinal braces. The knee braces were welded to the webs of tees on the bottom flange of the cap and the inside flange of the piles. The tees on the caps were welded in place on shore, and to eliminate waiting on tides (as indicated in Fig. 4) the pile tees were also welded to the knee-braces ashore.

Similarly longitudinal braces were prefabricated ashore. A combination work table and templet was set up, on which the frames with the plate connections to the piles were assembled and tack-welded, then removed and full-welded. For erection the braces were clamped into place and tack-welded.

Erecting deck steel

The final operation in the steel erection was placing the stringers and bolting the clip angles to take the nailing pieces. Using a transit, points were marked on each cap coincident with the center line of the pier. A templet, into which were notched the flange widths of the stringers at their proper spacing, was used in marking the position of the stringers on the caps. The stringers were then placed and tack-welded into place, and later full-welded.

The timberwork of the deck is clearly indicated by Fig. 2. Creosoted piles driven at mid-point between bents and bolted to the wales form the fender system. These piles are chocked with 8x10-in. timbers bolted between piles to the wales (Fig. 1).

Welding operations

Two portable 300-ampere gasoline-powered welding machines did the welding. During the normal hours, one of these was generally employed in tack-welding members, the other in completing the welds. The standard weld was $\frac{3}{8}$-in. fillet; welds around bent plates were slightly larger. All joints and contacting surfaces were completely sealed against corrosion. Sealing beads were $\frac{3}{16}$-in. fillet. About 9,000 lb. of welding rod ($\frac{1}{8}$ to $\frac{1}{4}$ in.) was used on the work; the $\frac{1}{8}$-in. rod was used for all overhead and vertical welds, and the $\frac{5}{32}$ in. size for most other welds.

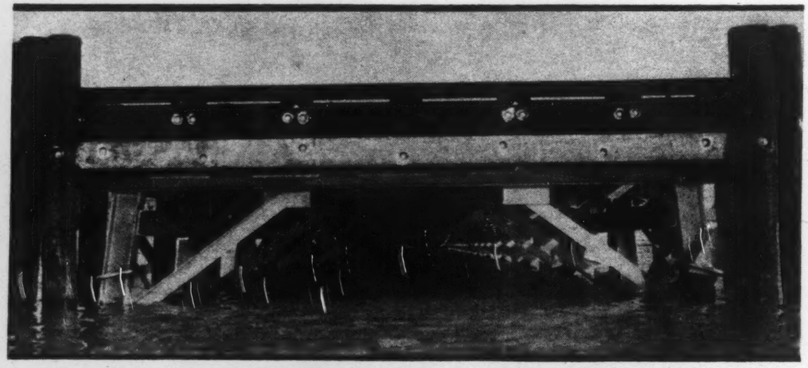

Fig. 4. **An underview of a pier from the water shows an excellent alignment of piles and bracing.**

"Rainmaker" Helps Soil Conservation

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Consulting Engineer, Denver, Colo.

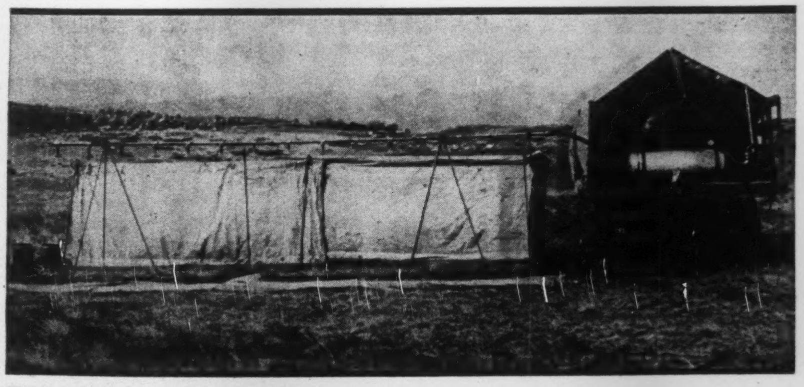
***Contents in Brief**—A pump-spray device developed by engineers working in the Soil Conservation Service gives controlled rainfall rates over small areas and so makes possible a rational design of surface contouring to reduce concentrations of runoff from severe storms to a minimum. Data on soil absorption in severe rain storms are a by product.*

AN ARTIFICIAL rainmaking device is being used in soil-conservation engineering to determine the runoff rates which govern the spacing of the terrace ditches on terraced land. It was devised for the project of the Soil Conservation Service, north and east of Colorado Springs on the headwaters of Sand Creek, Black Squirrel Creek and tributaries of Fountain Creek.

On this project the land slopes from 1 to 30 per cent, and the soils vary widely in nature, from heavy clay to pure sand. Precipitation is often intense, as much as 4 in. of rain having been recorded in one hour. The original rank growth of grama and mixed grasses was first overgrazed and later plowed under to raise grops to support the excess herds of the early settlers during the winter. In the planted fields, straight rows were the rule, regardless of slope. During the war many acres were planted to wheat, and after a few years of such cropping the land became depleted. Depleted land, several dry years and poor prices raised the cost of production above the market value of the product, with the result that many thousand acres of the land were abandoned to weeds, principally Russian thistles, and wind erosion followed water erosion. The problem encountered in trying to remedy these conditions is that of retaining as much rainfall as possible. Contour furrowing and terracing, water spreading, small dams at the head of the drainage areas, and flood-control dams, are the available means.

Runoff formulas not applicable

In the program of contour furrowing, determining the spacing of the furrows to provide the proper amount of pondage and so prevent serious overtopping and erosion was the chief problem, since ordinary runoff formulas do not apply to areas as small as that of a terrace width, say 30 to 200 ft. The available information on streamflow, runoff, precipitation and ground storage was not sufficient for even a foundation on which to build. Moreover, since the nearest precipitation station was 20 mi. away, it could give no information on the storm pattern and concentration. Nor was the influence of soil character on amount of runoff known. Only actual runoff measurement with artificial rain of various controlled amounts could answer the question.



"Rainmaker," equipped with tanks and pump, sprays a 9x14-ft. area enclosed by canvas; resulting runoff is measured to determine proper spacing of furrows.

The rainmaker that was developed comprises a truck-mounted supply tank and a pressure tank feeding a spray pipe 6 ft. above ground. A hand pump forces the water from the supply tank into the pressure tank, which is fitted with a gage glass. The sprayed area, 9 x 14 ft., is enclosed with curtains to prevent loss of rain from wind, and a gathering tank at the lower side of the sprayed area enables the runoff to be measured. By means of the pump and pressure tank any rain pattern may be simulated as to length and intensity.

Runoff, it was found, is not proportional to slope but depends on the physical and chemical characteristics of the soil and the density and type of vegetative cover. Fine dust from a dust storm acts as an impervious coating and prevents downward percolation. The soil reacts in many different ways. In one test on sandy loam with 1 per cent slope, a 4½-in. "rain" gave 70 per cent runoff; another test on 5 per cent slope gave no runoff at all—the difference due entirely to soil conditions. A repeat test on the 1 per cent slope 24 hr. later gave 35 per cent runoff.

To determine the precise influence of soil absorption, surface tension, porosity, capillarity, salt content, gas pressure, etc., would require long-time intensive experimenting and analysis. But a practical answer suiting the needs of the present project was obtained with rainmaker tests on the different soils.

Rain "patterns", or time-distribution of rainfall, affects runoff. One type of rain quickly reaches a peak, then decreases, and later again rises to the highest rate of precipitation. In such rain the surface-tension resistance of the soil particles can be broken, which enables the ground to absorb more water. In another kind of rain, there is a steady rise to a peak and then a steady fall to the end of the storm. In the Colorado Springs area the former pattern appears to be most common.

Some of the soils were found to

have little absorbing capacity, so that the first part of a rainstorm filled the pores, and all following rainfall ran off almost completely. One test, for example, showed that the first 1 in. of rainfall produced only 40 per cent of runoff, while thereafter the runoff was nearly complete (90 per cent). Evidently, if a peak of rainfall occurs after the initial absorption period, the ditches between furrows are most apt to be flooded.

After collecting all the information possible, the spacing of the terrace banks was calculated from maximum rate of runoff and capacity of terrace ditch. Of course it varies according to the slope of the ground, so that a terraced field looks like a patchwork quilt rather than one with a definite plan.

In order to avoid the danger of serious erosion by overtopping of the furrows, small dams were placed at intervals in the ditches between them. These dams limit the overflow to an amount that will not overload the next furrow below.

The improvement brought about by the conservation works—contour furrows on moderate slopes, foot-of-slope ditches and spreading grounds on steep slopes, interception ditches with terraced spreaders on the steepest—is made evident by increased productive ability of the land and decreased erosion. Increased vegetation on a 2,500-acre farm enabled the owner to get as much rental as obtained from an unprocessed 6,000-acre place adjacent. Erosion was almost zero so long as the terrace banks were not overtopped. In a year's experience with terraces built in the way above described, only a few proved unable to hold all the runoff, in spite of the fact that some heavy storms occurred, one of them with 4½ in. of precipitation in 1½ hr. It seems fair to assume that the calculations based on "rainmaker" data were very nearly correct.

At first the cost of this land conservation was prohibitively high, being greater than the value of the land. But with greater knowledge of methods and better equipment, the cost has been reduced to average less than $2 per acre. Even grazing land will bear this amount of expenditure.

The writer acted as engineer for some of the irrigation interests in the lower Fountain Valley and in that capacity came in contact with and was privileged to study the work done by the Soil Conservation Service on the Colorado Springs project, which is under the direct charge of A. E. McClymonds as state coordinator and Edward Kinnear (recently superseded by Frank Kimball) as chief engineer.

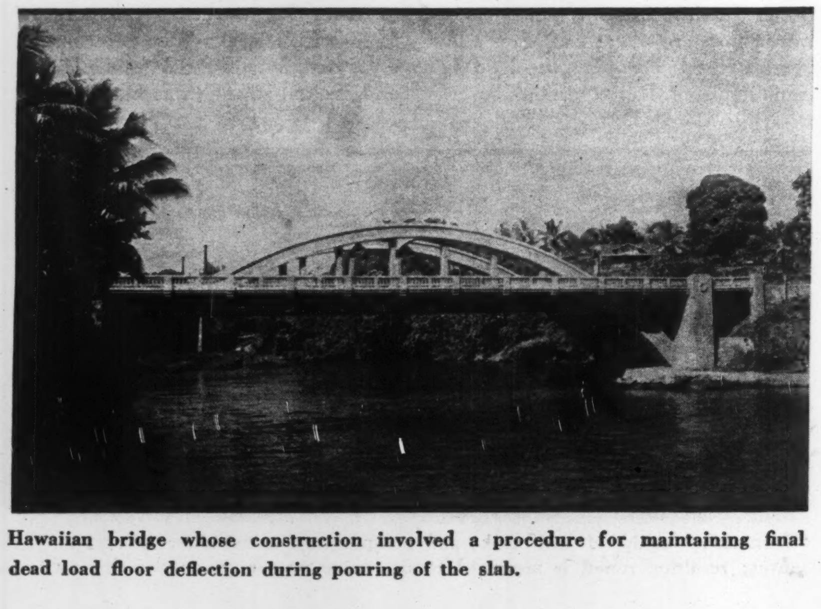
Controlling Bridge Deflection During Construction

Pig iron loaded on floor forms of Hawaiian bridge is progressively removed as concrete is poured

Requiring a design providing attractive lines because of its location in a tropical setting of continuously blooming flowers and green vegetation, the new crossing of the Wailuku River in Hilo, Hawaii, is also interesting by virtue of a construction scheme that maintained the full dead load deflection while the roadway was being poured.

The bridge consists of a reinforced concrete arch of 168-ft. span from which the concrete girder-and-beam floor is suspended by steel bar hangers incased in concrete. Timber arch false work for the arch ribs also carried the floor forms. After the arches were poured and cured and the floor forms erected, pig iron ballast, equal in weight and distribution to the concrete of the floor, was placed to produce the total dead load deflection. The pig iron was then removed progressively in amounts equal to the concrete placed, thus keeping the deflection constant and eliminating movement of the floor relative to the bar hangers whose ends had to be incased in the floor girders and thus should not be stressed by floor deflection until the concrete had an opportunity to set.

The bridge, completed and opened to traffic on Oct. 8, 1938, was a PWA project sponsored by the County of Hawaii at a cost of $110,000. The structure was designed by William H. Chun, project engineer for the county and built by Isemoto Contracting Co., Ltd., with T. Wakida as superintendent and Stanley Ho, assistant. Harry A. Ciufi, who supplied this information, was resident engineer inspector for the PWA.



Hawaiian bridge whose construction involved a procedure for maintaining final dead load floor deflection during pouring of the slab.

A Radio Water-Stage Recorder

MAURICE E. KENNEDY

Radio Engineer, Los Angeles County Flood Control District

***Contents in Brief:** Automatic gage-recording devices report water stages at remote points in the Los Angeles County Flood Control District by radio at predetermined times. Intervals between signals are reduced automatically as dangerous stages are approached. Automatic receiving station being developed.*

RECORDS OF WATER STAGES at remote points on mountain streams are sent out by radio from entirely automatic devices recently developed for the U. S. Geological Survey by the hydraulic department of the Los Angeles County Flood Control District. Two such installations provided with equipment whose design culminates three years of experimentation and tests with working models, are in operation this winter reporting the water stages at remote gaging stations on the San Gabriel River to a receiving station on San Gabriel Dam No. 1. The use of this equipment makes it unnecessary for the gaging stations to be visited more often than once a month at which time batteries are replaced and clock weights are wound up.

The design is quite simple, and the device can be set to operate once a day, once each hour or, when a critical water stage is reached, every 15 minutes. Transmitting antennas are of the semi-directional type with a marked signal gain in the direction of the recording receiver.

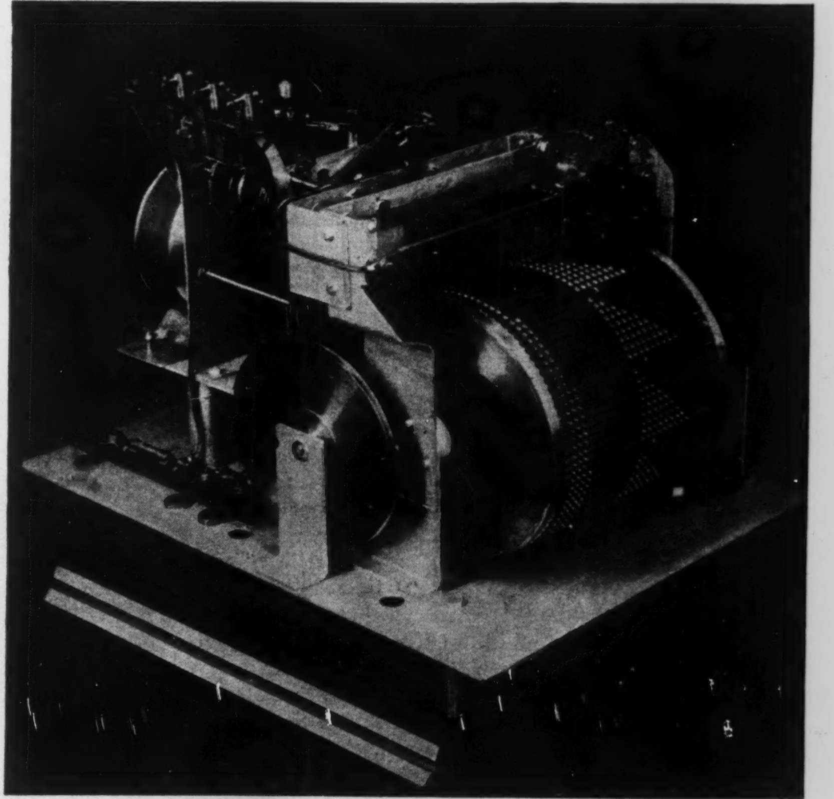
The water height is transmitted with the aid of a brass drum on whose surface there are 100 longitudinal grooves. Each groove has in it perforations representing coded readings of gage heights and perforations in each groove indicate a gage reading 0.1 ft. higher than the one preceding. This drum is connected with, and actuated by the float that rises and falls with the water level. The drum is so adjusted that the coded reading in the groove on the top of the drum corresponds with the height of the float.

At predetermined intervals the coded reading in the topmost groove is transmitted by an automatic radio mechanism. This is brought about by setting a simple time clock mechanism so that at predetermined intervals a small motor-driven trolley which supports the contacts for keying the radio transmitter, moves forward and back the length of the groove that happens to be on top at the time. On the forward trip the contacts transmit the coded gage reading indicated by perforations in the groove. On the return trip the groove contacts are inoperative but other contacts transmit the station call letters. This information is repeated three times (within a one-minute period of operation) in each broadcast.

Although the drum graduations are for 9.9-ft. only, any water level range can be reported by this device. For elevations above the 9.9-ft. limit, the attendant at the receiving end merely adds ten to the previous reading for each revolution of the drum.

The motor that drives the trolley is the small, permanent magnet type used by builders of small scale locomotives; its current consumption is about ½ amp. at 6 volts d.c. The timing mechanism includes several rotating disks; two rotate at the rate of one revolution per hour and one turns each 24 hours. Each disk has an index that can be set to the exact time at which transmission is desired. A notch in each disk, correspondingly set, passes under a metal finger which, at time of contact, tilts a mercury switch and closes a circuit.

For the reports at 15-min. intervals, to be sent out after the emergency level has been reached, use is made of one of the disks which rotate once each hour. This disk rotates continually and tips a mercury contact every 15 min. regardless of water stage. However, the circuit remains



The mechanism that transmits water level records. Symbols in adjoining grooves of the large drum on the right vary by 0.1 ft.

open until water level reaches the predetermined critical stage. Then the circuit is energized and the 15-min. mechanism operates the trolley that controls the radio broadcasts. When the water level again drops below the emergency stage, the normal interval between transmissions automatically is resumed.

The timing mechanism is operated by a clock whose mainspring has been replaced by a 15-lb. lead weight running over a drum. The weight descends into a pipe well at the rate of 6 in. per day. The depth of the weight well and the life of the storage batteries are the factors that limit operation between periods of inspection and service. The radio transmitter is a simple 4-watt quartz oscillator whose 270-volt plate power is supplied by heavy duty "B" batteries capable of service for more than a year. Filament current and power for the 6-volt motor is supplied by a storage battery.

In lieu of the radio broadcasting equipment the same type of recording device can be used to send the readings over a telephone circuit. However, the radio transmitter is preferred because of its relatively greater dependability during storm periods when wire lines might fail. The district now has under construction an automatic receiver that will receive the incoming reports in the form of a record inked on a moving tape. This recorder will start automatically with the first radio signal and stop 20 seconds after the complete reading is inked.

Water for the World's Fair

Contents in Brief: Unusual elements of the problem of providing water for a great temporary exposition are given in the following abstract of a paper by Benjamin Eisner, chief sanitary engineer, New York World's Fair, presented before the New York Section, A.W.W.A. Soft ground, still in the process of consolidation, and lack of information as to location of many buildings complicated the work. Pipe for both temporary and permanent installations includes 78 per cent asbestos-cement, 13 per cent cast iron, 9 per cent steel.

WATER SUPPLY and distribution facilities for the New York World's Fair were installed with the dual purpose of serving the Fair as well as meeting the requirements for a future park development. Principal water lines were placed to conform with park requirements rather than those of the Fair. Detailed locations for pipes, however, were dependent upon physical factors, including the planting of many large trees.

Standards of design were adopted to provide carrying capacities for all domestic purposes plus sufficient reserve for fire fighting. In this respect considerations of use through the Fair outweigh those of the future park. Pipe sizes are such that after meeting all other demands a flow of 3 m.g.d. can be provided without reducing street level pressures below 45 lb. per sq.in., or in case of a major conflagration supplying 8 m.g.d. irrespective of pressure drop.

Consumption estimates are based on the recorded experiences at the Century of Progress Exposition in Chicago, as reported by A. N. Wardle in the *Journal* of the Western Society of Engineers. Adjusted to the character, area and expected populations at the New York Fair these records formed the basis of estimating that the average daily total demand would be 7.6 m.g.; the total consumption on a maximum day 12 m.g., and the maximum hourly demand about 17 m.g.d. Drafts for air conditioning are not included in the above totals, since it is planned to confine water use largely to the night hours.

The system of mains, comprising about 13 miles of pipe work, contains two large mains which form part of the city distribution system. One of these is a 48-in. riveted-steel line built by the city, and the other a 20-in. cast-iron and steel main built by the Fair. These mains flank the exhibit area with the Fair system cross-connected between them and extending into the other sections of the site. There are seven points of connection to the city supply. Sizes of the local mains run from 6 in. (for single hydrant branches) to 12-in. dia.

Final selection of materials for both temporary and permanent mains was made to minimize total construction and operating cost. The system combines four types of pipe; 13 per cent of the length of which is cast iron; 3 per cent ½-in. thick steel; 6 per cent light gage steel and 78 per cent asbestos-cement.

Prior to installation of the larger water mains, a few mains of cast iron and light gage coated steel needed for immediate irrigation were installed. Service connections on the latter material were not easily made, and even with the most careful planning of "tees", this type of pipe did not meet the peculiar needs of the Fair where pipe was laid in advance of known demands. As a result, materials used subsequently were limited to cast iron and asbestos-cement. Permission was secured from New York City to use these materials for permanent park mains, and final choice was determined by bids.

Foundation conditions were cause for grave concern throughout construction and in particular where trenches lie in the fill occupying the original river channel or adjacent to new stream banks. Some of these areas were insufficiently consolidated when pipe was placed, and it was necessary to use piles and heavy stringers for support. Even after placement of such supports, leaks caused by general soil movements did occur. Leaks are to be expected, however, when it is realized that the mains are laid in an ash fill resting on mud, that heavy trucking passes over freshly filled trenches, that sewers and drains are frequently constructed close to and across water lines immediately after laying, and that the whole area has been undergoing continuous consolidation.

None of the mains is sufficiently old in service to justify final conclusions as to construction. The problems of maintenance faced during the construction period are decidedly different from those which are expected thereafter. For six months all main lines have been in place and in operation and during that time there has been no serious accident.

Better Bridge Floors

J. R. Burkey

Bridge Engineer, Ohio Department of Highways, Columbus, Ohio

***Contents in Brief**—Recent Ohio road bridges have been built with steel bulb-angle gutters and concrete floors finished by a vibrating templet developed in the bridge bureau of the state highway department. Devices for adjustment enable the gutters to be leveled and aligned to compensate for dead-load deflections and give a longitudinally accurate track for the vibrating templet. True curb and gutter lines result, the usable width of the floor is increased, vibration gives a better quality of concrete and the floor is smoother.*

Ohio is getting better floors on its road bridges by using steel gutters and a vibrating deck-finishing machine. Evidence is also submitted in the accompanying views that the floors are better in appearance. And it is true, although small illustrations do not show it very clearly, that gutter and curb and railing lines and grades are more exact. These are qualities that have commonly been difficult to secure in bridge floors because deflections developed by accumulating dead load often threw the finest of instrument prelocations out of position. The new gutter design meets the deflection difficulty in a very acceptable manner.

The steel gutter is not a new thought in Ohio road bridge construction; one was used (quite different from the present form) on the Lorain steel arch viaduct (*ENR*, July 9, 1936), and a more recent application was on the concrete arch viaduct at Fosters Crossing in Ohio (*ENR*, July 28, 1938).

As recently somewhat standardized, the gutter is shown by Fig. 2. It consists of a copper-bearing steel bulb-angle section, which is supported on steel stringers or on the deck forms by adjustable supports spaced about 4 ft. on centers. Small scuppers of welded copper-bearing steel are spaced at intervals of 15 to 20 ft. depending on the width of the roadway, and are supported on adjustable supports similar to the gutters, which are provided in short lengths to overlap the sides of the scuppers, the joints being sealed with continuous fillet welds.

When steel stringers are used those on the outside are located near the curb lines to provide support for the gutters and to permit the scuppers to discharge between stringers; where the gutters are supported on the deck forms, cone nuts are incorporated in the adjustable supports and the bolts and cone nuts are removed with the forms so that the holes can be filled with concrete. Additional lateral rigidity which may be necessary when the gutters are supported on the forms and heavy finishing equipment rides on the gutters can be provided by welding an occasional transverse slab-reinforcing bar to the bottom of the gutter sections or to their supports. The gutters are adjusted to compensate for dead load deflections, by using the deflection tables for main

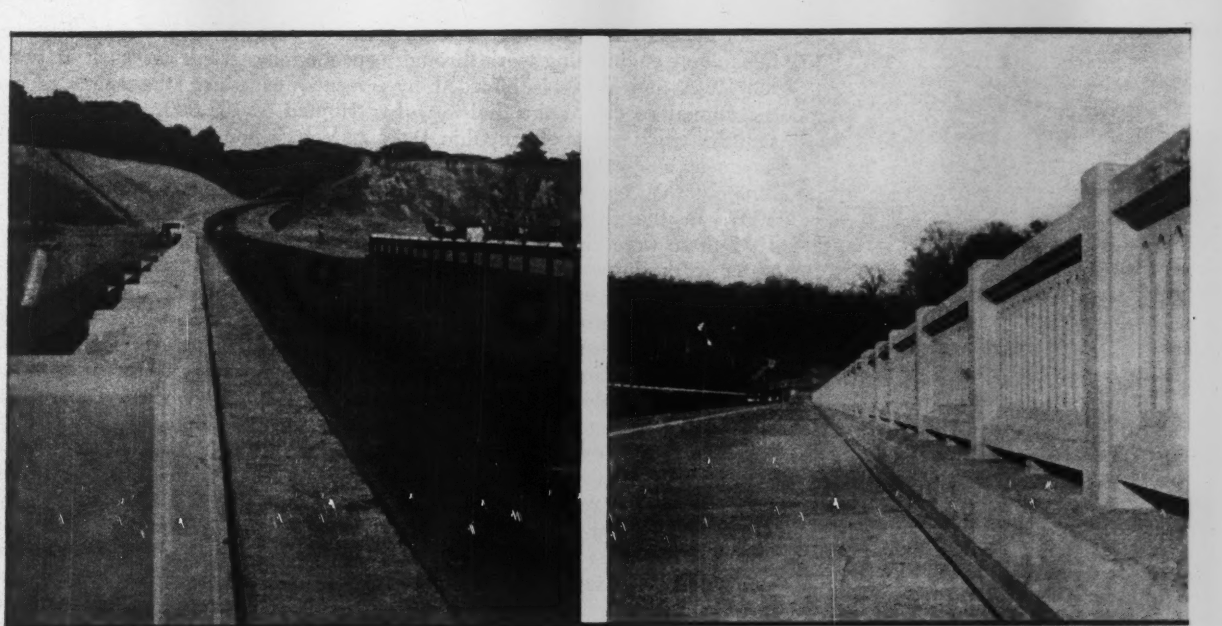
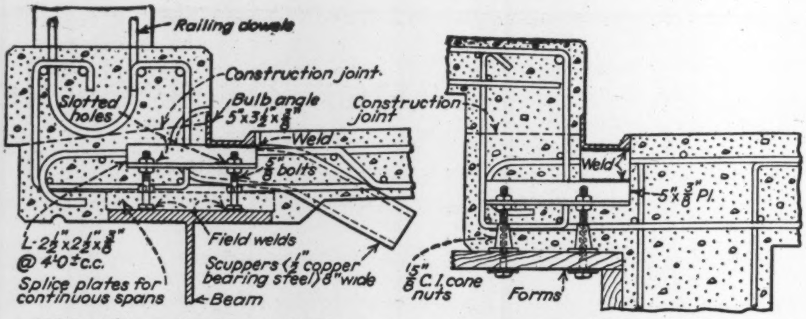


Fig. 1. Steel gutters add to the neat appearance of recent Ohio road-bridge floors and facilitate deck construction.



Gutters Supported on Outside Beams of Steel Bridges

Gutters Supported on Deck Forms of Concrete Bridges

Fig. 2. Steel gutters are so supported that they can be adjusted to line and grade as the structure deflects under the accumulating dead load of the roadway paving.

supporting members that are usually shown on construction drawings.

All portions of the gutters left exposed after the deck concrete is placed are painted with two coats of lead and two coats of aluminum; the surfaces in contact with concrete are not painted. It is believed that these gutters can be easily maintained, since they are copper-bearing steel and are easily accessible for painting.

Besides giving drainage for the pavement the gutters provide ideal track rails for the finishing equipment and permit the curbs to be placed after the deck slab has been placed and any necessary falsework removed; practically all dead-load stress in the curbs is thus eliminated. Railing dowels which would otherwise complicate the placing and finishing of the slab may also be omitted until the curbs are placed. The vertical leg of the bulb angle seals the construction joint between slab and curb and the angle provides an accurate support for the curb forms.

On the Fosters viaduct the steel gutters were used as a track for machine finishing the deck slab. The finishing machine consisted of a light welded-steel truss with a single gasoline-powered vibrating unit mounted on the center of the bottom chord. Various widths of plates were attached to the bottom chord angle to determine the most desirable width of strike-off. A 4 in. plate, giving a total width of about 6 in. appeared to give best results; when the angle was used without plates, a tendency was noted for the concrete to heave on the back side. The single vibrating unit appeared to give uniform vibration over the full length of the truss. Considerable work was saved in the finishing of the slab, and the vibration improved the denseness and smoothness of the finished concrete. To avoid excessive vibration, the templet is provided with a cam arrangement which raises the strike-off above the slab surface when the vibrator is idling. When this equipment is used, the concrete must have a relatively low water-cement ratio, which in itself contributes to quality.

The 24-ft. templet, used on the Fosters viaduct, was operated by two men at each end. It is believed, however, that for greater roadway widths a hand-operated winch might be necessary to assist in advancing the templet.

The development of the steel gutter and the vibrating templet may be credited quite largely to W. H. Rabe, chief designing engineer of bridges, and D. H. Overman, in charge of details of design in the bureau of bridges, Ohio highway department.

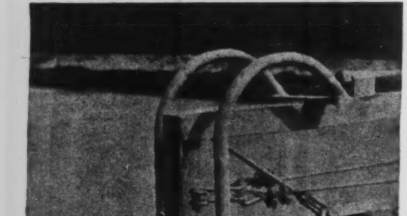


Fig. 3. Carriage ends of the vibrating finishing machine ride in the troughs of the bulb angle gutters and a lever-operated cam lifts the screed off the concrete when the finisher is idle.

Sanitary Engineering Under Federal Aid in Ohio

An illustration of federal assistance in sanitary engineering work through the PWA and WPA is afforded by the annual report of the division of sanitary engineering of the Ohio Department of Health, although unfortunately this report is for the year 1937. In the four years including 1937 there were under the PWA 118 water works improvements valued at $16,848,782, and 96 sewerage or sewage disposal improvements valued at $32,751,859. These improvements included 58 new waterworks systems in villages previously without such facilities, 37 new water treatment plants, 49 extensions to existing water works systems, 13 new and complete sewerage systems, 32 new sewage treatment plants and 70 extensions to existing sewerage systems. Projects under the WPA included many water works and sewerage improvements, the evaluation of which is extremely difficult. Up to November, 1937, a total of $27,553,154 had been expended by WPA on such improvements, of which the sponsors contributed $4,131,000.

Voted bond issues afforded the municipal funds to considerable extent, but a good proportion was raised by means of revenue bonds. The mortgage revenue bonds permitted by the state constitution since 1912 were popular during the four year period, and about 70 municipalities employed this method of financing water works and sewage disposal improvements. Certain special work occupied nearly 50 per cent of the field work of the division during 1937, including: (1) investigations as to flood conditions, (2) supervision of sealing acid mine drainage from abandoned coal mines, (3) milk sanitation surveys, (4) supervision of State roadside park sanitation, and (5) instructing local health department sanitarians.

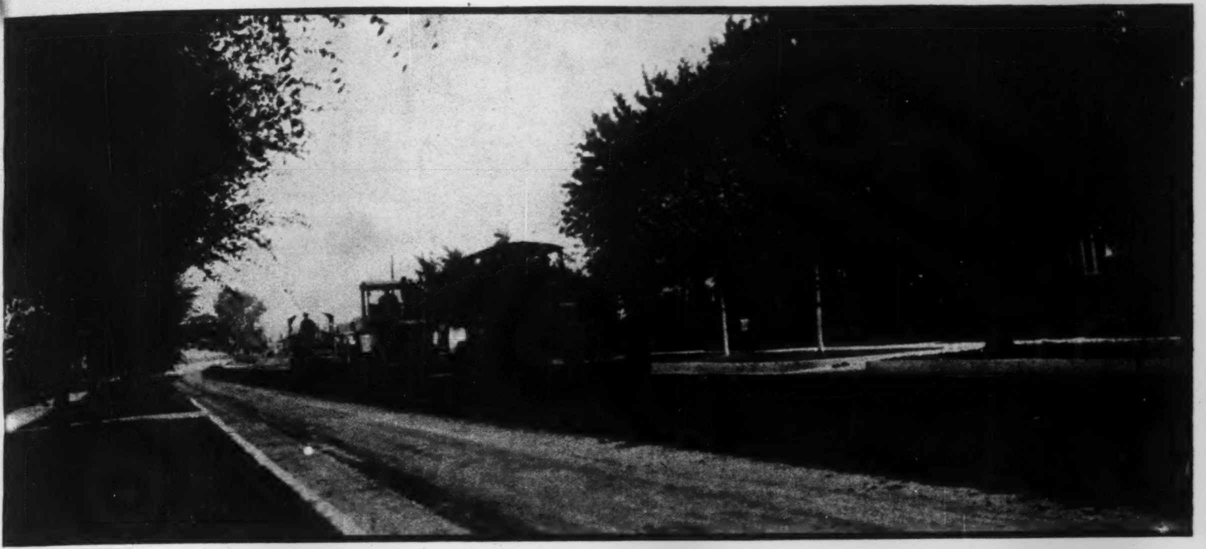


FIG. I. MOTOR GRADERS PROCESS OIL AND AGGREGATE FOR SURFACING A COLORADO SPRINGS STREET.

A Cheaply Paved City

C. H. Bryson

Superintendent of Streets, Colorado Springs, Colo.

***Contents in Brief** — Colorado Springs is building surfaced streets, good ones, for 12½c. a square yard. Local materials combined for suitable particle gradation and processed with oil by formula, coupled with scrupulous attention to detail in construction, account for good quality at low cost. Working details are given of aggregate treatment, mat processing and base construction.*

In six years 1,293,310 sq.yd. of processed-in-place bituminous-mat surfacing has been placed on the streets and alleys of Colorado Springs, Colo., at a cost of about 12½c. a sq.yd. This is not all of this kind of road that the city has constructed. Like other cities of the Centennial State, Colorado Springs has a large area of mountain parks and it has built some 10 mi. of bituminous-mat roads in these parks. Then there are cemetery and private drives and runways for the city airport that with the streets and alleys and park roads make up a total of 1,759,923 sq.yd. or the equivalent of 150 mi. of 20-ft. bituminous-mat road.

The cost of 12½c. a sq.yd. applies particularly to street and alley surfacing. This is laid to a compacted thickness of 1 in. The airport runways and the mountain park roads are 1½ in., but all surfaces whether 1 in. or 1½ in. thick have the edges thickened to 2½ or 3 in. The account here is confined largely to the 1-in. work, that is, the street and alley work that has been done nearly altogether by street department employees and equipment.

Method of financing

The practical interest in this work lies in the construction conditions and methods and these are given in working detail, but to start with clear understanding something of the procedure in financing the improvements needs to be told. Briefly the surfacing of streets and alleys is petitioned for by the abutting property and when a sufficient number of these petitions have been filed, an improvement district is formed, and upon the completion of the work the benefited property is assessed at the rate of 15c. per sq.yd. of surfaced street. The city pays the cost of intersections. No bonds have ever been issued, the city paying its share and financing the property owner's part, until assessments are paid, out of its working capital.

The foundation soil over about 40 per cent of the area of the city is a natural gravel or sand, but over the remaining 60 per cent of the city area it is an adobe clay which in most cases remains dry and stable. In the adobe territory all streets and alleys have in past years been surfaced with gravel to a thickness of from 1 to 6 in. Where the gravel is thin it is general practice to construct a new gravel base at least 4 in. thick.

Local material is used both for the base and as aggregate for the bituminous mat. For aggregate the local gravels lack fines (—200 mesh) and these are supplied by slimes from an old gold reduction mill. The resulting aggregate from the mixture is given in Table I.

Until the beginning of the 1938 season all gravel was hand loaded, but during the winter of 1938 a gravel loading, screening and crushing plant (Fig. 2) was assembled from used parts and built in the street department shops, and the operation of this plant during the 1938 season cut the cost of gravel delivered on the streets with an average haul of about 2½ mi. from 60c. per cu.yd. to 35c. per cu.yd. The capacity of this plant is about 300 cu.yd. in eight hours.

Practically all asphaltic oil used in this work has been SC3, or slow-curing oil, having an asphalt content of not less than 65 per cent nor more than 75 per cent. Cutback asphalt MC3 has been used on several streets but the results obtained have not been noticeably different from those obtained from the SC3. Cutback asphalt RC2 has been used on all seal-coat work, but this seal coating is not done under construction but under maintenance.

Constructing the base

The first step in construction is to cut out, with a motor grader, along the edge of the grade to the edge thickness of from 2½ to 3 in. The grader also blades the entire width cutting out any minor irregularities and corrugations, and with the material from the edges, the cut from the surface material, and all loose gravel on the surface, makes a windrow in the center of the street. This windrow is measured every 100 ft. and the volume per lineal foot computed.

The total aggregate required to make the compacted mat is computed and to this amount is added the extra amount necessary to make the thickened edges; a sufficient quantity for a maintenance ridge (about 0.25 cu. ft. per lin. ft. for average widths), and the amount required to lay alley and street intersections. If the compacted thickness is to be 1 in. the amount of gravel required is taken as the number of square feet of surface area multiplied by 0.10 ft. plus the volume required to make the thickened edges and the volume for the maintenance ridge less the center windrow of gravel salvaged from the old gravel surfacing. If the compacted thickness is to be 1½ in. the area in square feet is multiplied by 0.15 ft.

TABLE I — AVERAGE SIEVE ANALYSIS OF MINERAL AGGREGATE WHICH IS PROCESSED WITH ASPHALTIC OIL FOR MAT SURFACES

Particle Size	Per Cent
Passing a ¾-in. sieve	100
Passing a ¾-in. retained on ⅜-in. sieve	8
Passing a ⅜-in. retained on a No. 10 sieve	38
Passing a No. 10 retained on a No. 48 sieve	31
Passing a No. 48 retained on a No. 100 sieve	6
Passing a No. 100 retained on a No. 200 sieve	4
Passing a No. 200 (by washing) sieve	13

Dump trucks loaded to 65 cu.ft. each are used in the gravel haul and from the computations outlined above, are dumped on the windrow of salvaged gravel so as to leave the necessary amount of gravel per lineal foot. Samples are taken of both the gravel salvaged from the street, and from the pit gravel trucked in, and from a sieve analysis of these combined in their proper proportions, the deficiency of fines or material passing the 200-mesh sieve is determined. The windrow of gravel is then staked for the proper dumping of the fines. This windrow consisting of gravel salvaged from the street, pit gravel trucked in and mill slimes, is now dry mixed by motor graders until the moisture content does not exceed 1 per cent by weight.

The next step is to broom the base by a power broom to remove all dust ready for the hot (175–200 deg.F.) SC3 base prime coat applied at a rate of 0.15 gal. per sq.yd. by a distributor (Fig. 3). The entire base is covered by the prime or tack coat, the windrow of aggregate being moved by the motor graders onto the prime-coated portion to allow the remainder of the base to be broomed or prime coated. There is no doubt that the SC1 or SC2 oil or MC1 cutback would be more suitable for the tack or prime coat, but limited storage facilities prevent using them. From a sieve analysis of a composite sample of the aggregate the amount of the SC3 oil required is computed. There are several formulas for this, the principal ones being those of the New Mexico and Wyoming highway departments given in Table II.

Computing the oil

From the average composition sieve analysis, which is given in

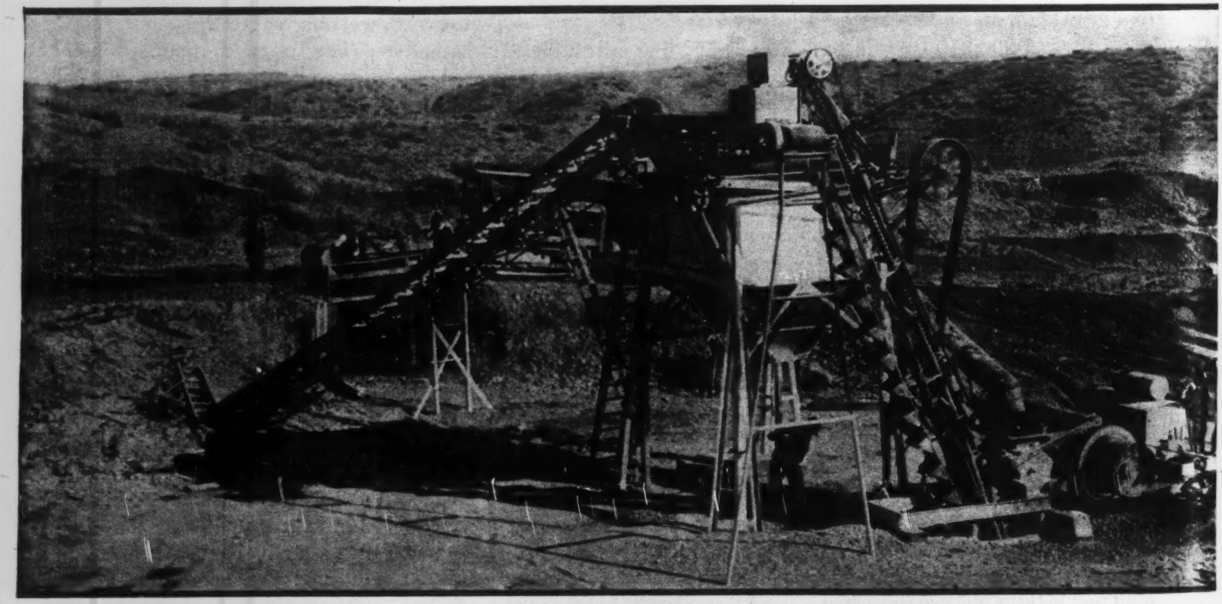


Fig. 2. A home-made gravel loading and screening plant cut the cost of gravel delivered an average of 2½ miles to street and alley paving jobs in Colorado Springs from 60c. to 35c. a square yard.

Table I, the oil content from the New Mexico formula figures 5.1 per cent and from the Wyoming formula 5.78 per cent. The aggregate sieve analysis is run through both formulas and 92 per cent of the mean, which would be 5.02 per cent, is used.

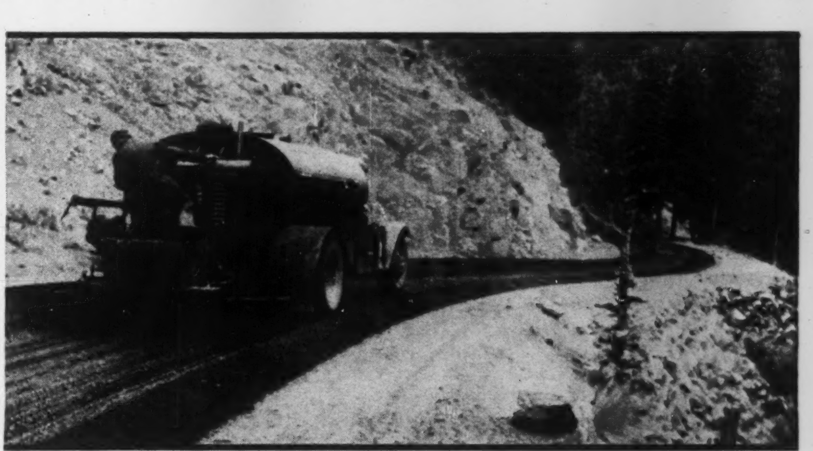


Fig. 3. Oil distributor working on bituminous mat surface for one of the mountain park roads of Colorado Springs.

After the computation of the amount of oil is made, it is reduced to the number of spreads over the length of the street with 10-ft. spray bars and at a rate of 0.2 gal. per sq. yd. A final spread with a 5-ft. bar at a 0.2-gal. rate or with a 10-ft. bar at a 0.1-gal. rate, is sometimes given to make the exact gallonage. The distributor operator is given a memorandum of the total gallonage, corrected to 60 deg. F. temperature, and the number of spreads and rate per square yard.

Processing the mat

The dry aggregate is spread over from one-fourth to one-half the width of the street and the application of the hot SC3 oil (150–175 deg.F.) is started. One motor grader follows immediately behind the distributor turning dry aggregate over the hot oil. This is continued until the entire amount of oil is applied when mixing or processing with two or more motor graders is commenced. This mixing is continued until the entire mass is of uniform color and texture and contains no balls of oil and fines. If rainfall occurs during the processing, partly mixed oil and aggregate is windrowed as quickly as possible and kept in a windrow until the rain is over and the base thoroughly dried. Processing is then resumed and continued until all moisture is worked out and the mass uniformly mixed. Upon the completion of mixing, one motor grader is used in laying, this being done in light lifts from the windrow which has been moved to one side of the street, until there only remains enough material in the windrow for the maintenance ridge and to build the intersections.

Immediately following the laying of the mat, rolling with a nine-wheeled pneumatic-tired roller pulled by a 1½-ton truck is started at one gutter or edge and continued to the outer gutter or edge, lapping about two-thirds of the roller width each trip. After rolling, a light center-control motor grader picks up the remaining maintenance ridge and with a light blade pressure only sufficient to cut off high places, carries the ridge across the street and back again. This maintenance is necessary daily until a large percentage of the volatile oils is evaporated and set has taken place; this is usually in three or four days.

If the finished street is wider than 30 ft., barricades 16 ft. wide are placed forcing the traffic to the edges for a sufficient length of time to compact the edges thoroughly, and if the street is 50 ft. or more in width the barricades are moved after the edges are compacted, and placed so that the center of the street only is open to traffic. When the barricades are placed so as to force all traffic to the edges, temporary No Parking signs are erected back of the curbing. This barricading is done only during daylight hours.

The equipment used by the city street department on the work has a good-weather production capacity of about 125,000 sq.yd. of 1-in. mat per month and is as follows:

1 Model 200 Municipal Supply Co. bituminous distributor mounted on a model T51 GMC truck
1 1,200-gal. capacity insulated tank oil trailer (used only on airport and mountain park work)
8 1½-ton dual rear wheel trucks with hydraulic dump bodies. (These trucks also haul aggregate)
1 Model 65 Caterpillar tractor with model 64 Killefer rotary fresno scraper (used at the gravel plant only during 1938)
1 Gravel screening and crushing plant with 15 cu.yd. bin. (used only during 1938)
2 Model 77 Austin tandem-drive motor graders with 10 ft. oil mix moldboard
1 Model 151 Adams tandem-drive motor grader with 10 ft. oil mix moldboard
1 Model No. 11 Caterpillar diesel auto-patrol with 12 ft. oil mix moldboard
1 Wehr Fordson center-control motor grader with 8 ft. moldboard
1 9 ft. width Buckeye sand and chip spreader (used only on maintenance seal coat work).

The bituminous-mat surfacing which has been laid on streets, airport and mountain park roads during the past six years has been entirely satisfactory both from the city's and the taxpayer's standpoint. Its low cost, freedom from dust and smooth riding surface under all conditions, and its ability to carry large storm water flows without scouring the gutters, has given about 100 per cent taxpayer approval. The maintenance cost to date has been much lower than that of gravelling, sprinkling and smoothing gravel-surfaced streets.

The total cost to the city at large and the benefited abutting property for the 1,295,310 sq.yd. of this work done on city streets and alleys in improvement districts amounted to $161,930.

TABLE II—TWO WELL KNOWN OIL FORMULAS COMBINED IN CALCULATING THE OIL CONTENT OF BITUMINOUS MATS FOR COLORADO SPRINGS' STREETS

New Mexico

$P = 0.02a + 0.07b + 0.15c + .2d$
P = per cent of oil by weight to dry weight of aggregate
a = per cent of aggregate retained on No. 48 sieve
b = per cent of aggregate passing a No. 48 and retained on No. 100
c = per cent of aggregate passing a No. 100 and retained on No. 200
d = per cent of aggregate passing a No. 200 sieve

Wyoming

$P = (0.015a + 0.03b + 0.17c)\ 1.4$
P = per cent of oil by weight to dry weight of aggregate
a = per cent of aggregate retained on No. 10 sieve
b = per cent of aggregate passing No. 10 retained on No. 200 sieve
c = per cent of aggregate passing No. 200 sieve

Inventory of Sewage Disposal Facilities

***Contents in Brief**—The need for a survey of sewage disposal facilities in the United States was recognized by* Engineering News-Record *a decade ago when the first inventory was attempted. Because of incomplete data then in existence the survey served principally to prepare the way for a second and more comprehensive inventory, which was successfully undertaken in 1935. The following study, patterned after the 1935 inventory, is a factual measure of progress and trends. The data are from the official records of the 48 state sanitary engineers, whose interested and generous cooperation made possible this valuable compendium.*

MORE THAN HALF of the urban population in the United States is provided with sewage treatment facilities, according to a nation-wide survey just completed by *Engineering News-Record.* This represents a gain of 52 per cent in the three years since the 1935 survey, and strikingly evidences the rapid advance being made in providing better sanitation facilities. Construction of disposal plants in 1,200 communities during this period reflects the availability of federal grants and loans, the aggressive educational efforts of health authorities, and an enlightened public consciousness toward stream pollution abatement.

The survey, which was compiled from official data furnished by state sanitary engineers, includes for each of the 48 states information on the number of people and communities served by sewers and treatment plants, the number and type of disposal plants, and a detailed tabulation showing the major processes of treatment now in use.

The 1938 inventory reveals that there are 4,667 communities in 47 states with treatment plants, and these plants serve 40,884,800 people; this is 52 per cent of the urban population. In 1935 there were plants in 3,471 communities in 44 states serving 24,195,000 people. New York leads the list of states in total number of people served by treatment works, caring for 5,539,000 in this way. Arranged in the order of population served, the first eight states are as follows:

New York	5,539,000
Illinois	4,822,000
New Jersey	3,320,000
Ohio	3,027,000
California	2,973,000
Michigan	2,760,000
Texas	2,700,000
Wisconsin	1,353,000

With regard to the number of communities served by treatment plants, however, the lead is taken by Texas where the total is 425. States in which 100 or more communities have installed disposal plants are shown in the following table:

Texas	425	Minnesota	176
New Jersey	263	Pennsylvania	170
New York	256	Kansas	156
Iowa	249	North Carolina	154
Illinois	239	Ohio	140
California	237	Missouri	132
Oklahoma	181	Arkansas	123
Wisconsin	178	Michigan	119

On a regional basis it will be noted from the following tabulation that the Middle West ranks first in the percentage of total urban population served by disposal works. The New England area is at the bottom of the list. This classification indicates that the New England and Southern

STATE HEALTH DEPARTMENT OFFICIALS WHO SUPPLIED DATA

G. H. Hazlehurst	**Chief Engineer**	**Alabama**	**T. A. Filipi**	**Public Health Engineer**	**Nebraska**
F. C. Roberts, Jr.	**Sanitary Engineer**	**Arizona**	**W. W. White**	**Sanitary Engineer**	**Nevada**
F. L. McDonald	**Chief Engineer**	**Arkansas**	**Chas. D. Howard**	**Director**	**New Hampshire**
C. G. Gillespie	**Chief, Bur. of San. Eng.**	**California**	**J. Lynn Mahaffey**	**Director**	**New Jersey**
Benj. V. Howe	**Sanitary Engineer**	**Colorado**	**Paul S. Fox**	**Chief**	**New Mexico**
Warren J. Scott	**Director of San. Eng.**	**Connecticut**	**C. A. Holmquist**	**Director**	**New York**
Rich. C. Beckett	**Sanitary Engineer**	**Delaware**	**W. H. Booker**	**Director**	**N. Carolina**
G. F. Catlett	**Chief Engineer**	**Florida**	**Mark D. Hollis**	**Director**	**N. Dakota**
W. H. Weir	**Asst. Director**	**Georgia**	**F. H. Waring**	**Chief Engineer**	**Ohio**
W. V. Leonard	**Sanitary Engineer**	**Idaho**	**H. J. Darcey**	**Chief Engineer**	**Oklahoma**
C. W. Klassen	**Chief Sanitary Engineer**	**Illinois**	**Carl E. Green**	**Sanitary Engineer**	**Oregon**
B. A. Poole	**Chief Engineer**	**Indiana**	**H. E. Moses**	**Chief Engineer**	**Pennsylvania**
A. H. Wieters	**Director**	**Iowa**	**Eskil C. Johnson**	**Engineer**	**Rhode Island**
Earnest Boyce	**Chief Engineer**	**Kansas**	**B. P. Rice**	**Sanitary Engineer**	**S. Carolina**
F. C. Dugan	**Director**	**Kentucky**	**W. W. Towne**	**Director**	**S. Dakota**
John H. O'Neill	**Sanitary Engineer**	**Louisiana**	**W. C. Williams**	**Commissioner**	**Tennessee**
E. W. Campbell	**Director**	**Maine**	**V. M. Ehlers**	**Director**	**Texas**
Geo. L. Hall	**Acting Chief Engineer**	**Maryland**	**L. M. Thatcher**	**Director**	**Utah**
A. D. Weston	**Chief Engineer**	**Massachusetts**	**E. L. Waterman**	**Sanitary Engineer**	**Vermont**
Edw. D. Rich	**Director**	**Michigan**	**Richard Messer**	**Director**	**Virginia**
H. A. Whittaker	**Director**	**Minnesota**	**Roy M. Harris**	**Chief**	**Washington**
H. A. Koreze	**Director**	**Mississippi**	**E. S. Tisdale**	**Director**	**W. Virginia**
W. Scott Johnson	**Chief Pub. Health Eng.**	**Missouri**	**L. F. Warrick**	**Sanitary Engineer**	**Wisconsin**
H. B. Foote	**Director**	**Montana**	**L. O. Williams, Jr.**	**Sanitary Engineer**	**Wyoming**

Inventory of Sewage Disposal Faci

State	Incorporated Places	Sanitary Districts	Communities Served by Public Water Supplies	Population				Communities With Sewerage Facilities				Ownership			Degree of Treatment (Number of Communities Whose Treatment Ends With):													
															Sewage Farms or Land Disposal		Screening		Primary Sedimentation		Oxidation							
				Total Urban (Places at 2,500 Population and over)	Included in Sanitary Districts	Served by Sanitary Sewers	Served by Treatment Plants	Separate Sanitary Sewers	Combined Storm and Sanitary Sewers	Storm Sewers Only	Sewage Treatment Plants	Privately Owned Public Sewerage Systems	Systems Provide Income Through Rentals	Industrial Waste Treatment Plants	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Course Screens	Grit Chambers	Fine Screens	Screenings Shredding	Screenings Incineration	Grease Separat
New England																												
Me.	48	1	190	550,000	6,000	....	9,015	.....	.....	...	8	...	...	...	...	...	...	...	8	...	...	...	1	...		...		
N. H.	235	0	126	273,079	0	267,800	36,200	<—65—>		...	9[15]	0	2	0	0	0	0	0	6	1	1	1	1	0	0		0	0
Vt.	75	0	111	118,766	0	....	....	<—66 systems—>				...	...	...	...	...	...	...	1	1		...	2	1	0	...	0	2
Mass.	39	...	248	4,350,910	....	3,813,146	677,800	<—122—>		...	79[1]	1	16	15	1	...	42	...		1	35	...	15	3	0		0	1
R. I.	39	0	80	635,247	....	435,000	360,000	11	4	...	13	0	0	10	0	0	0	0	2	4	7	...	9	2	0		0	1
Conn.	44	1	166	1,131,770	1,300	1,136,477	752,864	64	25	...	64[2]	8	1	...	0	0	2	0	18	14	23	7	42	22	7	1	5	0
TOTAL	**480**	**2**	**921**	**7,059,772**	**7,300**	**5,652,423**	**1,835,879**	**75**	**29**	**0**	**173**	**9**	**19**	**25**	**1**	**0**	**44**	**0**	**35**	**21**	**66**	**8**	**70**	**28**	**7**	**1**	**5**	**4**
								<—187—>																				
								<——66——>																				
Middle Atlantic																												
N. Y.	615	1	1,131	10,875,388	372,100	10,828,255	5,538,560	325	73	...	256	39	1	180	0	1	5	33	72	71	34	40	203		17		7	
N. J.	566	8	437	4,028,000	1,220,000	3,968,250	3,139,500	<—288—>		...	263[3]	7	...	48	1	0	1	3	59	61	25	49		...	6	6		
Pa.	204	0	....	6,957,631	0	6,022,700	1,744,733	.....	.....	...	170[19]	19	...	240	1	0	1	0	45	67	15	41	189	11	1	7		0
Md.	137	4	122	974,869	198,031	1,254,300	1,085,200	76	25	...	70	3	16	16	0	0	0	3	23	20	16	8	41	1	2	3	2	11
Del.	47	...	30	153,384	....	155,971	36,587	22	7	2	19	0	0	0	...	...	...	...	5	6	2	6	15	...			1	...
D. C.	....	1	1	....	487,000	487,000	487,000	.....	1	...	1	0	0	0	...	...	...	...	1	...	.....		1	1	...		...	1
TOTAL	**1,569**	**14**	**1,721**	**22,989,272**	**2,277,131**	**22,716,476**	**12,031,580**	**423**	**106**	**2**	**779**	**68**	**17**	**484**	**2**	**1**	**37**	**39**	**205**	**225**	**92**	**144**	**449**	**13**	**26**	**16**	**10**	**12**
								<—288—>																				
Southern																												
Va.	205	12	407	902,112	49,870	978,506	148,113	208	.....	...	93	...	...	2	0	0	0	0	28	25	18	22	18	3	0		3	3
W. Va.	260	0	237	800,000	0	600,000	58,000	<—230 systems—>			12	3	8	18	0	0	0	0	8	1	1	2	3	0	0		0	0
N. Car.	50	22	286	1,080,797	35,000	974,641	505,031	213	1	...	154[20]	2	23	7	0	0	0	0	101	16	35	2	61	56	0	6	0	5
S. Car.	265	0	207	521,323	....	451,610	212,300	2	87	0	63	0	0	0	0	0	0	0	51	0	10	2	26	26	0		0	0
Ga.	563	0	337	895,492	0	1,057,000	550,000	<—160—>		0	84	0	15	1	0	0	0	0	70	2	11	1	41	28	0	5	0	
Fla.	289	3	....	989,743	1,000	894,365	538,688	110	1	0	86	0	6	0	0	0	0	2	68	9	7	0	0	0	2	...	0	0
Ala.	297	1	272	744,273	431,493	639,953	334,481	167	0	0	81	...	12	1	...	...	1	1	63	3	10	3	2	...			1	
Miss.	313	0	197	521,885	0	407,735	86,547	99	0	0	54	0	0	0	0	0	0	0	37	8	2	7	6	...				
La.	214	0	167	1,050,000	0	977,000	132,400	58	0	...	35	5	4	0	0	0	0	0	10	0	20	5	1	0	0	...	0	
Ky.	383	0	202	1,130,000	0	921,750	176,009	150	6	1	42	0	3	10	0	0	0	0	16	6	12	8	26	26	0	...	4	
Tenn.	233	0	207	1,500,000	0	968,888	184,058	101	2	...	57	10	11	0	0	0	0	0	44	4	9	0	10	0	0		0	1
TOTAL	**3,528**	**38**	**2,519**	**10,135,625**	**517,363**	**8,871,448**	**2,925,627**	**1,108**	**97**	**1**	**761**	**20**	**82**	**39**	**0**	**0**	**1**	**3**	**496**	**74**	**135**	**52**	**194**	**139**	**2**	**11**	**8**	**11**
								<—160—>																				
								<——230——>																				
Middle West																												
Ohio	862	92[6]	508	4,989,999	201,151[6]	4,586,634	3,027,048	215	80	88	140[7]	1	49	75	0	0	1	0	35	17	62	25	132	32	2	...	6	
Ind.	524	1	304	2,098,950	380,000	1,900,000	730,000	<——190——>			67	1	20	8	0	0	0	1	17	0	43[12]	6	29	29	1		2	
Ill.	1,129	27	624	6,282,200	4,530,430	5,832,300	4,822,000	170	182	...	239	1	36	6	0	0	0	0	54	5	166	14	194	55	0	...	5	
Wis.	512	3	335	1,850,042	826,000	1,744,461	1,353,435	<—264—>		...	178[16]	0	4	...	0	0	0	0	99[16]	...	83[16]	...	104	15	2	16	4	
Mich.	475	0	409	3,506,800	0	3,506,797	2,760,664	116	180	...	119[14]	10	14	64	2	...	...	1	28	28	45	7	57	20		14	3	
TOTAL	**3,502**	**123**	**2,180**	**18,727,991**	**5,937,581**	**17,570,192**	**12,693,147**	**501**	**442**	**88**	**743**	**13**	**123**	**153**	**2**	**0**	**1**	**2**	**233**	**50**	**399**	**52**	**516**	**151**	**5**	**30**	**20**	
								<—264—>																				
								<——190——>																				
W. of Mississippi																												
Minn.	729	1	435	1,598,651	754,506	1,453,310	1,112,800	<—255—>		...	176[10]	0	4	6	0	0	0	0	93	25[10]	35	23	25	2	3	...	2	
Iowa	914	0	568	1,444,042	0	1,264,280	741,843	<—346—>		...	249	0	9	2	0	0	0	0	37	0	206	6	86	56	4	12	4	
Mo.	773	2	269	1,859,119	15,500	2,019,023	419,467	110	65	0	132	1	0	...	0	0	0	0	43	3	86	0	30	...	0			
Ark.	399	0	187	578,950	0	473,220	284,572	126	0	0	123	2	29	2	0	0	0	0	103	1	17	2	21	5	0	2	1	
N. Dak.	325	0	93	257,305	0	145,000	112,000	24	54	...	56	0	2	3	1	...	...	...	46	...	8	1	20	4			2	
S. Dak.	300	0	193	275,966	0	195,643	177,418	<—94—>		...	66	0	0	0	0	0	0	0	35	1	27	3	7	3	3	0	3	
Neb.	524	1	369	755,190	85,000	669,474	227,074	172	.....	...	85	3	...	0	1	...	0	...	26	...	58	...	6	2	0		1	
Kan.	586	0	355	1,055,279	0	906,184	603,879	204	1	0	156	0	0	...	0	...	0	...	35	...	121	...	61	4	0	6	15	1
Okla.	512	0	337	821,681	0	1,005,062	842,484	210	0	...	181[13]	0	0	0	0	0	0	0	84	1	92	4	158	3	0	...	1	
Tex.	600	8	803	2,829,458	....	3,000,000	2,700,000	440	3	...	425	66	286	43	58	7	0	0	186	75	138	24	100	200	32		20	10
Mont.	114	...	108	251,040	....	234,381	60,000	<—75—>		...	44	0	0	6	3[11]	0	0	0	44	1	0	0	6	0	0	...	0	
Wyo.	84	0	66	116,800	0	105,500	54,500	40	1	...	15	2	0	0	0	0	0	0	14	1	0	...	3	0	0	...	0	
Colo.	241	0	186	681,000	0	602,000	500,100	103	4	0	47	2	5	0	0	0	0	0	25	3	12	5	8	4	0	...	1	
N. Mex.	56	0	57	106,816	0	132,676	118,296	41	0	1	36	1	1	0	1[11]	0	...	...	30	0	4	1	16	16	0	...	0	
TOTAL	**6,157**	**12**	**4,026**	**12,631,297**	**855,006**	**12,205,753**	**7,954,433**	**1,470**	**128**	**1**	**1,791**	**77**	**336**	**62**	**64**	**7**	**0**	**0**	**801**	**111**	**804**	**69**	**547**	**299**	**42**	**20**	**50**	**12**
								<—770—>																				
Far West																												
Idaho	150	0	137	129,507	0	....	....	71	68	3	15	0	0	1	0	0	0	0	11	4	0	0	1	...	...	...		
Utah	161	0	218	366,988	0	288,463	46,600	51	1	...	23	17	1	1	10[11]	2[11]	0	0	21	0	2	0	0	0	0	...	0	
Ariz.	33	0	66	225,430	0	200,906	168,522	47	0	0	31	14	2	2	...	...	...	...	27	...	4	0	14	5	0	0	6	
Nev.	16	0	38	....	....	....	46,000	1	26	1	7[21]	5	1	0	0	0	2	3	2	...	.....	...	5	7	4	...	3	
Wash.	221	0	270	884,539	0	780,000	108,000	74	49	2	53	0	4	4	2	0	0	0	21	25	5	...	10	2	0	...	2	
Ore.	204	0	372	587,096	....	440,570	101,966	56	47	...	54[17]	0	10	0	0	0	0	0	37	1	6	10	15	4	0	0	0	
Calif.	282	57	380	4,910,000	283,000	4,853,000	2,973,000	350	17	...	237[18]	32	0	...	3[11]	...	5	1	138	2	44	30	...	1	10	2	2	
	1,067	**57**	**1,481**	**7,103,560**	**283,000**	**6,562,939**	**3,444,088**	**650**	**208**	**6**	**420**	**68**	**18**	**8**	**15**	**2**	**7**	**4**	**257**	**32**	**61**	**40**	**45**	**19**	**14**	**2**	**13**	
GRAND TOTAL	**16,303**	**246**	**12,848**	**78,647,517**	**9,877,381**	**73,579,231**	**40,884,754**	**4,227**	**1,010**	**98**	**4,667**	**255**	**595**	**771**	**84**	**10**	**90**	**48**	**2,027**	**525**	**1,559**	**365**	**1,821**	**649**	**96**	**80**	**106**	
								<——1,669——>																				
								<——420——>																				
								<————66————>																				

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[1] 20 industrial or institutional plants not included

[2] 8 private, 12 state institutional, 10 private industrial included

[3] 206 plants

[4] Includes only separate sludge digestion plants

[5] Includes some institutional and industrial plants

[6] County sanitary districts

[7] 140 plants in 135 communities

[8] Data as reported are approximate

[9] 60 industrial and institutional plants included

[10] 8 communities served by 1 plant

[11] No treatment before discharging

[12] 5 plants in intermediate stage not comp

[13] 196 plants

[14] 111 plants

[15] Municipal plants only

Inventory of Sewage Disposal Facilities—1938

	COMMUNITIES With Sewerage Facilities				OWNERSHIP			DEGREE OF TREATMENT (Number of Communities Whose Treatment Ends With):								MAJOR PROCESSES OF TREATMENT WORKS (Number of Plants Using):																												STATE
								Sewage Farms or Land Disposal		Screening		Primary Sedimentation		Oxidation								Primary Sedimentation					Filtration			Activated Sludge					Disposal of Sludge									
																																				Sludge Drying Beds					By-Product Utilization			
lants	Separate Sanitary Sewers	Combined Storm and Sanitary Sewers	Storm Sewers Only	Sewage Treatment Plants	Privately Owned Public Sewerage Systems	Systems Provide Income Through Rentals	Industrial Waste Treatment Plants	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Without Disinfection	With Disinfection	Coarse Screens	Grit Chambers	Fine Screens	Screenings Shredding	Screenings Incineration	Grease Separation	Without Coagulants	With Coagulants	Mechanical Sludge Removal	Septic Tanks	Imhoff Tanks	Contact Beds	Trickling Filters	Intermittent Sand Filters	Diffused Air	Mechanical Aeration	Secondary Sedimentation	Chemical Precipitation	Chlorination	Separate Sludge Digestion	Open	Covered	Sludge Lagoons	Mechanical Dewatering	Incineration	Fertilizer Production	Gas for Heat	Gas for Power	
																																												New England
,015	.....	.....	...	8	...	...	...	...	..	...	...	8	...	.....	..	1	..	..	..	..	..	8	..	1	7	1	..	.....	..	..	..	..	..	..	..	.....	1	..	..	..	..	..	..	Me.
,200	<—65—>		...	9[15]	0	2	0	0	0	0	0	6	1	1	1	1	0	0	..	0	0	12	0	0	8	4	0	1	3	0	0	1	0	3	0	6	..	0	0	0	0	0	0	N. H.
....	<—66 systems—>				...	...	...	...	..	...	...	1	1	.....	..	2	1	0	..	0	2	2	..	2	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	2	0	Vt.
,800	<—122—>		...	79[1]	1	16	15	1	..	42	...	.....	1	35	..	15	3	0	..	0	1	18	..	2	1	6	0	6	32	1	0	6	0	1	2	20	1	0	0	0	0	2	..	Mass.
,000	11	4	...	13	0	0	10	0	0	0	0	2	4	7	..	9	2	0	..	0	1	13	0	4	6	3	0	1	5	2	0	3	0	4	2	9	1	0	1	0	0	2	..	R. I.
,864	64	25	...	64[2]	8	1	...	0	0	2	0	18	14	23	7	42	22	7	1	5	0	70	2	16	29	18	0	2	24	1	1	5	2	26	19	39	16	7	5	3	0	8	0	Conn.
,879	**75**	**29**	**0**	**173**	**9**	**19**	**25**	**1**	**0**	**44**	**0**	**35**	**21**	**66**	**8**	**70**	**28**	**7**	**1**	**5**	**4**	**123**	**2**	**25**	**51**	**32**	**0**	**10**	**64**	**4**	**1**	**15**	**2**	**35**	**25**	**76**	**19**	**7**	**6**	**3**	**0**	**14**	**0**	**TOTAL**
	<—187—>																																											
	<———66———>																																											
																																												Middle Atlantic
,560	325	73	...	256	39	1	180	0	1	5	33	72	71	34	40	203	..	17	..	7	..	114	5	48	72	87	6	40	19	6	2	35	5	109	56	92	56	8	9	4	0	36	3	N. Y.
,500	<—288—>		...	263[3]	7	...	48	1	0	1	3	59	61	25	49	....	..	6	6	..	..	144	23	27	.....	48	2	42	21	4	2	48	14	114	48	51	47	0	5	3	12	15	1	N. J.
,733	.....	.....	...	170[19]	19	...	240	1	0	1	0	45	67	15	41	189	11	1	7	..	0	31[4]	0	21	101	130[5]	24	110	33	4	5	110	0	122	31	180	29	0	1	1	1	15	0	Pa.
,200	76	25	...	70	3	16	16	0	0	0	3	23	20	16	8	41	1	2	3	2	11	67	0	7	12	29	0	18	3	3	0	16	0	29	15	51	2	0	5	2	0	5	0	Md.
,587	22	7	2	19	0	0	0	...	..	...	...	5	6	2	6	15	..	..	..	1	..	11	..	2	2	6	..	6	2	..	..	..	..	12	4	12	3	..	..	..	..	1	..	Del.
,000	.....	1	...	1	0	0	0	...	..	...	...	1	...	.....	..	1	1	..	..	..	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	D. C.
,580	**423**	**106**	**2**	**779**	**68**	**17**	**484**	**2**	**1**	**37**	**39**	**205**	**225**	**92**	**144**	**449**	**13**	**26**	**16**	**10**	**12**	**368**	**28**	**106**	**187**	**300**	**32**	**216**	**78**	**17**	**9**	**209**	**19**	**386**	**155**	**386**	**137**	**8**	**21**	**10**	**13**	**73**	**5**	**TOTAL**
	<—288—>																																											
																																												Southern
,113	208	......	...	93	...	...	2	0	0	0	0	28	25	18	22	18	3	0	..	3	3	92	1	7	36	40	3	29	1	0	0	17	1	47	11	41	8	0	0	0	..	5	0	Va.
,000	<—230 systems—>			12	3	8	18	0	0	0	0	8	1	1	2	3	0	0	..	0	0	12	0	0	3	9	0	3	0	0	0	3	0	3	0	4	1	0	0	0	0	0	0	W. Va.
,031	213	1	...	154[20]	2	23	7	0	0	0	0	101	16	35	2	61	56	0	6	0	5	157	4	14	59	78	3	17	18	5	0	16	5	24	16	56	1	0	5	0	4	5	2	N. Car.
,300	2	87	0	63	0	0	0	0	0	0	0	51	0	10	2	26	26	0	..	0	0	61	0	2	37	24	..	9	2	..	2	1	0	2	..	30	0	..	0	0	0	2	1	S. Car.
,000	<—160—>		0	84	0	15	1	0	0	0	0	70	2	11	1	41	28	0	5	0	2	101	3	11	60	30	0	15	2	0	0	6	3	6	11	65	0	0	1	0	0	9	2	Ga.
,688	110	1	0	86	0	6	0	0	0	0	2	68	9	7	0	0	0	2	..	0	0	84	0	13	65	17	0	5	2	0	0	0	0	9	13	16	0	0	0	0	0	0	0	Fla.
,481	167	0	0	81	...	12	1	...	..	1	1	63	3	10	3	2	..	..	..	1	..	65	1	6	59	12	1	4	1	..	..	21	1	7	6	18	..	..	..	..	..	2	..	Ala.
,547	99	0	0	54	0	0	0	0	0	0	0	37	8	2	7	6	..	..	..	..	..	52	0	0	49	9	1	5	2	0	0	2	0	15	3	8	0	0	0	0	0	0	0	Miss.
,400	58	0	...	35	5	4	0	0	0	0	0	10	0	20	5	1	0	0	..	0	0	33	0	0	15	18	3	16	3	1	1	1	0	5	4	22	0	0	0	0	0	4	0	La.
,009	150	6	1	42	0	3	10	0	0	0	0	16	6	12	8	26	26	0	..	4	0	32	1	3	10	26	3	14	1	2	2	6	1	14	5	32	0	0	0	0	0	3	0	Ky.
,058	101	2	...	57	10	11	0	0	0	0	0	44	4	9	0	10	0	0	..	0	1	56	0	2	30	25	0	7	1	1	0	2	0	6	2	26	0	0	0	0	0	1	0	Tenn.
,627	**1,108**	**97**	**1**	**761**	**20**	**82**	**39**	**0**	**0**	**1**	**3**	**496**	**74**	**135**	**52**	**194**	**139**	**2**	**11**	**8**	**11**	**745**	**10**	**58**	**423**	**288**	**14**	**124**	**33**	**9**	**5**	**75**	**11**	**138**	**71**	**318**	**10**	**0**	**6**	**0**	**4**	**31**	**5**	**TOTAL**
	<—160—>																																											
	<———230———>																																											
																																												Middle West
,048	215	80	88	140[7]	1	49	75	0	0	1	0	35	17	62	25	132	32	2	..	6	5	132	7	41	15	71	10	34	29	15	2	30	7	42	48	101	25	6	5	3	6	40	2	Ohio
,000	<———190———>			67	1	20	8	0	0	0	1	17	0	43[12]	6	29	29	1	..	2	1	65	0	18	18	32	2	38	2	4	1	36	0	6	15	42	6	2	2	2	1	14	4	Ind.
,000	170	182	...	239	1	36	6	0	0	0	0	54	5	166	14	194	55	0	..	5	2	211	3	53	43	112	0	68	19	10	26	52	3	26	58	157	3	40	3	3	1	32	9	Ill.
,435	<—264—>		...	178[16]	0	4	...	0	0	0	0	99[16]	...	83[16]	..	104	15	2	16	4	1	93	10	91	24	42	0	47	11	2	9	56	10	24	97	135	4	0	4	2	1	74	12	Wis.
,664	116	180	...	119[14]	10	14	64	2	..	...	1	28	28	45	7	57	20	..	14	3	..	105	2	41	38	24	3	20	21	5	9	14	2	36	39	61	13	4	6	2	1	37	4	Mich.
,147	**501**	**442**	**88**	**743**	**13**	**123**	**153**	**2**	**0**	**1**	**2**	**233**	**50**	**399**	**52**	**516**	**151**	**5**	**30**	**20**	**9**	**606**	**22**	**244**	**138**	**281**	**15**	**207**	**82**	**36**	**47**	**188**	**22**	**134**	**257**	**496**	**51**	**52**	**20**	**12**	**10**	**197**	**31**	**TOTAL**
	<—264—>																																											
	<———190———>																																											
																																												W. of Mississippi
,800	<—255—>		...	176[10]	0	4	6	0	0	0	0	93	25[10]	35	23	25	2	3	..	2	1	163	1	28	8	121	0	47	1	0	10	53	1	40	36	151	1	1	1	1	..	20	0	Minn.
,843	<—346—>		...	249	0	9	2	0	0	0	0	37	0	206	6	86	56	4	12	4	4	38	6	31	121	117	6	99	124	0	3	61	3	6	37	245	..	3	3	0	0	32	3	Iowa
,467	110	65	0	132	1	0	...	0	0	0	0	43	3	86	0	30	..	0	..	..	0	131	0	14	28	79	4	46	1	0	8	13	1	7	12	57	0	1	0	0	0	6	0	Mo.
,572	126	0	0	123	2	29	2	0	0	0	0	103	1	17	2	21	5	0	2	1	0	120	3	45	11	43	5	8	5	1	0	3	5	3	28	96	0	0	0	0	0	2	0	Ark.
,000	24	54	...	56	0	2	3	1	..	...	...	46	...	8	1	20	4	..	..	2	0	45	2	5	29	19	..	7	0	1	..	2	2	2	4	11	0	1	..	..	0	4	..	N. Dak.
,418	<—94—>		...	66	0	0	0	0	0	0	0	35	1	27	3	7	3	3	0	3	2	65	1	7	4	55	0	22	6	1	1	10	1	4	7	.....	0	..	0	0	0	7	0	S. Dak.
,074	172	.....	...	85	3	...	0	1	..	0	...	26	...	58	..	6	2	0	..	1	0	64	6	15	14	33	0	29	5	1	12	20	3	1	22	58	0	3	0	0	0	3	0	Neb.
,879	204	1	0	156	0	0	...	0	..	0	...	35	...	121	..	61	4	0	6	15	11	23	2	25	24	106	12	51	41	9	2	59	2	2	29	141	1	3	0	0	0	23	2	Kan.
,484	210	0	...	181[13]	0	0	0	0	0	0	0	84	1	92	4	158	3	0	..	1	1	94	15	21	38	131	3	85	1	1	3	6	21	16	20	160	0	0	1	0	0	4	0	Okla.
,000	440	3	...	425	66	286	43	58	7	0	0	186	75	138	24	100	200	32	..	20	100	49	7	17	110	294	9	111	40	<-20->		18	12	49	19	435	2	8	1	0	1	24	0	Tex.
,000	<—75—>		...	44	0	0	6	3[11]	0	0	0	44	1	0	0	6	0	0	..	0	..	4	0	0	37	3	0	0	6	0	0	0	0	1	0	40	0	0	0	..	0	0	0	Mont.
,500	40	1	...	15	2	0	0	0	0	0	0	14	1	0	..	3	0	0	..	0	0	15	0	0	12	3	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	Wyo.
,100	103	4	0	47	2	5	0	0	0	0	0	25	3	12	5	8	4	0	..	1	2	26	5	13	18	15	0	8	1	0	0	2	5	8	13	47	0	0	1	1	0	14	0	Colo.
,296	41	0	1	36	1	1	0	1[11]	0	...	...	30	0	4	1	16	16	0	..	0	..	36	0	3	15	18	0	5	1	0	0	0	0	1	6	17	0	0	0	0	17	0	0	N. Mex.
,433	**1,470**	**128**	**1**	**1,791**	**77**	**336**	**62**	**64**	**7**	**0**	**0**	**801**	**111**	**804**	**69**	**547**	**299**	**42**	**20**	**50**	**121**	**873**	**48**	**224**	**469**	**1,037**	**39**	**518**	**232**	**14**	**39**	**247**	**56**	**141**	**233**	**1,461**	**4**	**20**	**7**	**2**	**18**	**139**	**5**	**TOTAL**
	<—770—>																													**<-20->**														
																																												Far West
....	71	68	3	15	0	0	1	0	0	0	0	11	4	0	0	1	..	..	...	..	..	15	0	3	....	2	2	2	..	0	0	1	0	4	2	....	..	..	..	..	..	2	0	Idaho
,600	51	1	...	23	17	1	1	10[11]	2[11]	0	0	21	0	2	0	0	0	0	..	0	0	23	0	0	20	3	0	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	Utah
,522	47	0	0	31	14	2	2	...	..	...	...	27	...	4	0	14	5	0	0	6	0	30	3	9	15	6	..	2	1	2	0	2	4	6	15	11	0	4	0	2	4	5	0	Ariz.
,000	1	26	1	7[21]	5	1	0	0	0	2	3	2	...	.....	..	5	7	4	..	3	0	11	0	6	4	1	0	0	0	0	0	1	0	3	6	7	0	2	..	..	..	3	0	Nev.
,000	74	49	2	53	0	4	4	2	0	0	0	21	25	5	..	10	2	0	..	2	0	53	0	6	42	2	2	2	1	..	1	2	..	20	6	12	0	0	0	0	0	4	0	Wash.
,966	56	47	...	54[17]	0	10	0	0	0	0	0	37	1	6	10	15	4	0	0	0	0	13	0	9	34	6	3	8	4	3	0	11	0	8	13	15	1	0	0	0	0	8	1	Ore.
,000	350	17	...	237[18]	32	0	...	3[11]	..	5	1	138	2	44	30	....	1	10	2	2	2	226	0	37	78	104	2	50	28	11	5	36	0	44	56	163	1	2	1	0	107	15	4	Calif.
,088	**650**	**208**	**6**	**420**	**68**	**18**	**8**	**15**	**2**	**7**	**4**	**257**	**32**	**61**	**40**	**45**	**19**	**14**	**2**	**13**	**2**	**371**	**3**	**70**	**193**	**124**	**9**	**65**	**35**	**16**	**6**	**53**	**4**	**87**	**98**	**208**	**2**	**8**	**1**	**2**	**111**	**37**	**5**	
,754	**4,227**	**1,010**	**98**	**4,667**	**255**	**595**	**771**	**84**	**10**	**90**	**48**	**2,027**	**525**	**1,559**	**365**	**1,821**	**649**	**96**	**80**	**106**	**159**	**3,086**	**113**	**727**	**1,461**	**2,062**	**109**	**1,140**	**524**	**96**	**107**	**787**	**114**	**921**	**839**	**2,945**	**223**	**95**	**61**	**29**	**156**	**491**	**51**	**GRAND TOTAL**
	<———1,669———>																													**<-20->**														
	<———420———>																																											
	<———66———>																																											

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gestion plants

ndustrial plants

[8] Data as reported are approximate

[9] 60 industrial and institutional plants included

[10] 8 communities served by 1 plant

[11] **No treatment before discharging**

[12] 5 plants in intermediate stage not completely final

[13] 196 plants

[14] 111 plants

[15] **Municipal plants only**

[16] 2 communities have both primary and complete plants

[17] 66 plants

[18] 220 plants — land disposal following treatment at 78 **primary treatment plants and 21 oxidation or complete treatment**, lagoons at 8 complete treatment plants

[19] 273 plants including institutions but not private plants

[20] 165 plants

[21] **12 plants**

UNIV. OF MICH

regions have not advanced their programs for sewage treatment at the same rate that the country as a whole has achieved.

Middle West	68.5 per cent
West of Mississippi	65.3
Middle Atlantic	52.4
Far West	48.5
Southern	31.4
New England	26

More than half of the communities treating their sewage (actually 54 per cent) provide primary treatment by sedimentation according to the data compiled under the heading "Degree of Treatment." So-called complete or oxidation treatment has been adopted by 44 per cent of the communities. Disinfection of effluents prior to their discharge is employed in only 20 per cent of all the plants, however. This low figure is somewhat surprising because much emphasis has been placed on the desirability of this practice.

Further analysis of treatment types and of processes employed in the 4,667 communities surveyed is given in the section of the table included under "Major Units of Treatment Works." It is of particular interest to report that the number of activated-sludge plants almost doubled during the last three years and that trickling filter installation showed a 43 per cent gain.

Sludge disposal statistics

The trend of the times in sludge disposal is revealed by the statistics which show that separate sludge digestion facilities are now in use in 839 plants (in 48 states) as compared with 374 installation (in 44 states) in 1935. Air-drying on sand beds is by far the most common method of handling digested sludge, some 3,170 plants engaging in this practice; of this number only 223 places report the use of covered beds. Mechanical dewatering of sludge is gaining in popularity, the number of installation jumping from 19 to 61 in three years. Incineration, likewise, went forward and at the present time there are 29 installations as compared with only 6 in 1935.

Reports on by-product utilization show that 542 communities are collecting sludge gas. The most general application of the gas is for the production of heat, but 51 plants have installed gas engines for power production. The use of sludge for fertilizer is reported by 156 communities.

Computing Bond Stress In Unequal Bar Layouts

Roy E. McFee
Detroit, Mich.

A recent tendency in reinforced concrete design is an increased attention to bond stress. This is bringing inquiry into bond stress formulas and specifications.

A particular consideration is that in which the system of tension steel in a beam consists of bars of different sizes. The usual practice in calculating bond in all cases has been to use the formula $u = \frac{V}{\Sigma_o jd}$. In this particular case Σ_o would be the sum of the perimeters of the bars without distinction as to different sizes. Yet with such an arrangement of bars, the customary formula actually applies only after very special qualification.

Suppose a beam is continuous over a support. Assume that 1⅛ in. sq. bars at 6-in. centers, providing 2.52 sq.in. of steel for a ft. width of beam, are just sufficient to take the negative moment. Let the shear on a particular section containing these bars be 25,000 lb. for a ft. width of beam. The value of d is 20 in. To check for bond, the formula $u = \frac{V}{\Sigma_o jd}$ is used. The result is $\frac{25{,}000}{9 \times \frac{7}{8} \times 20}$ = 159 lb., which is an excessive amount.

Now suppose that a second arrangement of steel is tried. The 1⅛ in. sq. bars are reduced to 1 in. sq. bars, but still at 6-in. centers, and with ½ in. sq. bars laid between. The new system then has 1-in. sq. bars alternated with ½-in. sq. bars at 3-in. centers. The cross-section of steel provided is 2.50 sq. in. for a ft. of beam, which is practically the same as the first design. If, in checking again for bond, the formula $u = \frac{V}{\Sigma_o jd}$ is used, the result is $\frac{25{,}000}{12 \times \frac{7}{8} \times 20}$ = 119 lb., which appears satisfactory.

Yet this figure for bond stress is misleading. The error lies in the assumption that the small bars will develop as much bond to the sq.in. of surface as the large bars. This they cannot do, as is made clear by a moment's reflection on the nature of bond stress. Bond is simply the increment of stress, put into the steel by the concrete. The tension at the point of maximum moment is the total of all the bond acting on the bar at one side of that point. Now, with the beam deflecting uniformly, the unit tensile stress at this point is exactly the same for the smaller bar as for the larger bar. Then the total tensile stress in the ½-in. sq. bar is only one-fourth that of the 1 in. sq. bar. Therefore the total of all the bond of the smaller bar can be only one-fourth that of the larger bar. But the perimeter of a ½-in. sq. bar is 2 in., while the perimeter of a 1-in. sq. bar is 4 in., only twice as much. This means that the smaller bar need accumulate only one-fourth as much total bond with a perimeter one-half as great. Consequently, when 1-in. sq. bars and ½-in. sq. bars are used together as tension steel, the developed bond to the square inch for the smaller bar will be exactly one-half that which is developed for the larger bar.

Correct solution

A correct solution of the above problem follows: Since the 1 in. sq. bars have 80 per cent of the cross-section of steel, they will take 80 per cent of the shear, and therefore 80 per cent of the total bond. Then correct calculations for unit bond would be

$$u_1 = \frac{.80 \times 25{,}000}{8 \times \frac{7}{8} \times 20} = 143 \text{ lb. for}$$

the 1 in. sq. bars

$$u_2 = \frac{.20 \times 25{,}000}{4 \times \frac{7}{8} \times 20} = 71.5 \text{ lb. for}$$

for the ½ in. sq. bars

According to this, the second arrangement of bars is also unsatisfactory for bond.

FROM AN EDITOR'S NOTEBOOK

Travel notes made by editors on their visits to men in the field

ENTERING the office of Ralph Rizer, city engineer of Cumberland, Md., I was greeted with a question. "Say, what do you know about designing a bear pen?" Fortunately he did not wait for an answer but continued. "Nothing like municipal public works to keep a fellow on his toes—bear pen design is not included in engineering training courses, but our new park is going to have a zoo and the city engineer has got to build it."

This was the prelude to an interesting day with a public works administrator who is doing a particularly effective job of city improvement. As in most other municipalities, the work is being done with WPA labor—almost 1,300 men are employed on a program embracing street construction, sewer and water lines and development of a 62-acre park containing a swimming pool, animal dens, a bandstand, and a pistol range.

The principal rehabilitation is going on in South Cumberland, a section of the city so far behind in its physical services that it is referred to as "Old Egypt." The street improvement work consists of putting in monolithic concrete curbs and gutters and pavements consisting of an 8-in. limestone base filled with stone chips and waterbound and covered with a 1-in. black top surface. The width of the new pavements, 40 ft. in almost every case, is a striking contrast to the narrow streets in Cumberland.

One of the principal problems in street improvement comes about because of the difference in street width and alignment where adjoining subdivisions meet. "My experience," says Mr. Rizer, "points to the absolute need for subdivision regulation and control by the city engineer or planning board."

Fig. 1. Ralph Rizer, city engineer of Cumberland, Md.

The swimming pool at the park is 76x200 ft., with the deep section in the center—a departure from ordinary practice. This design was based on the results of surveys which show that only 30 per cent of the people using a pool prefer the deep section. Accordingly, the pool was laid out so that 70 per cent of the area, equally divided on each end, is available for the majority of the users who do not go into deep water.

Low cost construction was sought for the locker rooms and shower building adjoining the pool, and this was achieved by using concrete blocks made on the job by WPA labor, using a standard machine mold; the rental for the machine was based on a royalty of one penny for each block.

Rizer is enthusiastic about the manner in which the WPA program is progressing. The projects in the city are divided into four groups, and field operations for each group are in charge of a supervisor. The supervisor is a member of the city engineering staff, and therefore thoroughly familiar with the city's routine and method of doing things.

Coordination of purpose, men and equipment, said Rizer, is a primary requisite for effective work. And it is to this end that a meeting is held every Friday attended by supervisors, key men on each project, and the local WPA engineer. Such a meeting furnishes an opportunity to formulate plans for the coming week and to acquaint all responsible parties with what is going on.

But we didn't spend the entire day talking about WPA and bear pens. A huge aerial map of the city hanging on the wall of the office attracted my attention. In answer to my reference to it Mr. Rizer said: "I would almost rather lose my right arm than be without that map. It was made in 1930 at a cost of $3,000. For accuracy and completeness we couldn't duplicate it with ground surveys at ten times that price. From the completed aerial photographs, made on a scale of 1 in. to 400 ft., a tracing was made and this serves as the official city map. And everything is on it."

The only field surveys that were made in connection with the aerial mapping were for establishing control points on the ground at the city boundary lines. Wood crosses, painted white and large enough to be visible from the air, were placed at these points and appear on the aerial photos. —E. J. C.

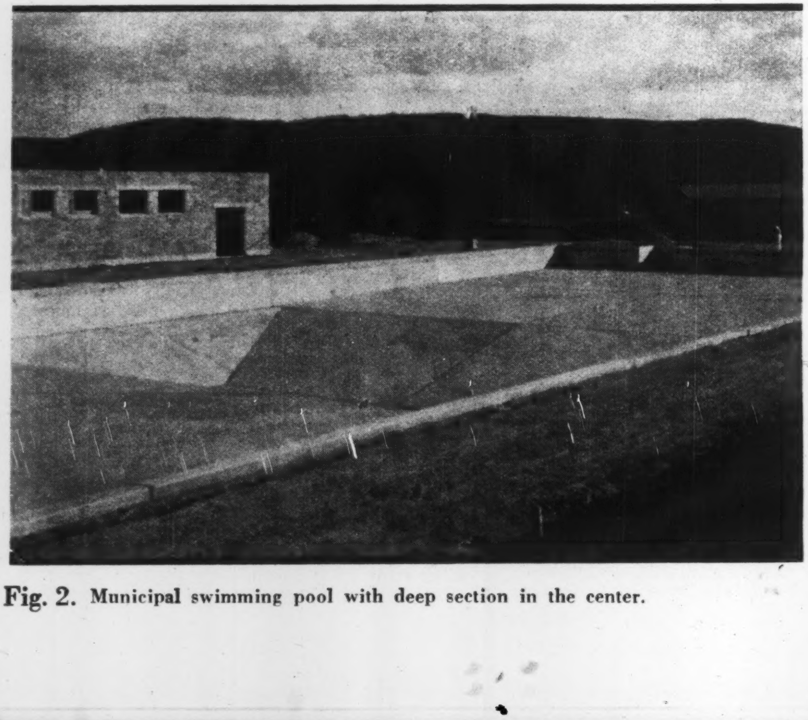

Fig. 2. Municipal swimming pool with deep section in the center.

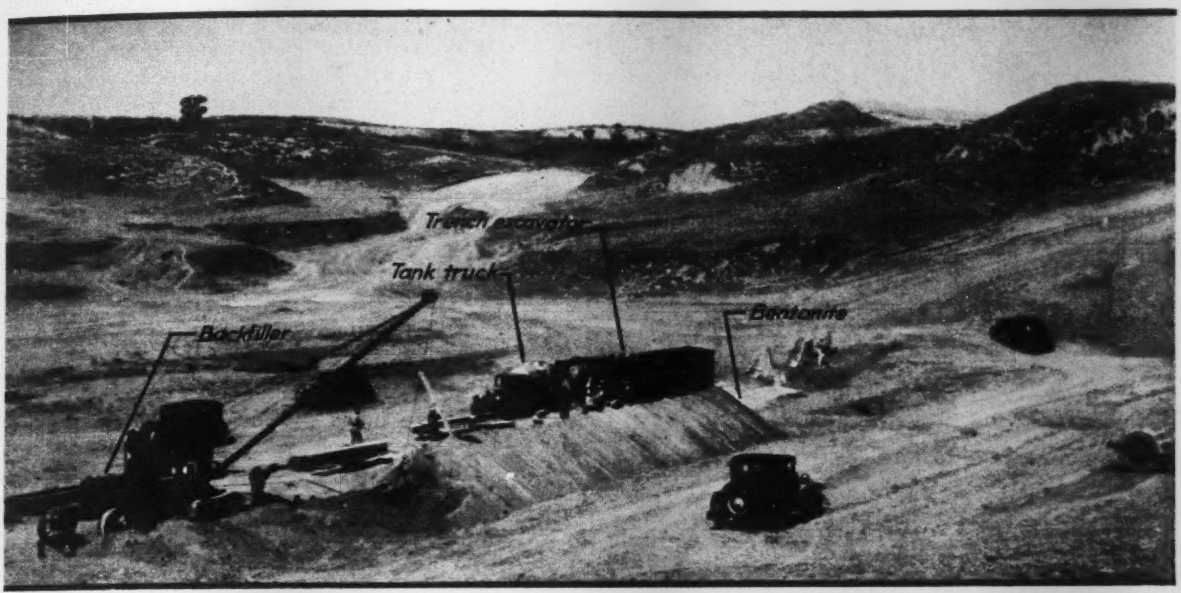

FIG. I. TRENCHING MACHINES MIX BENTONITE WITH SOIL FOR BACKFILLING DAM CUTOFF TRENCHES

Trencher Digs and Mixes Cutoff Materials

W. J. Turnbull

Soils Engineer, Central Nebraska Public Power and Irrigation District, Ogallala, Neb.

***Contents in Brief**—A mixture of five per cent bentonite and ninety-five per cent soil is being used for cutoff trenches in small dams along canals of the Tri-County Project in Nebraska. Trench excavators are made to mix the bentonite and soil as the trenches are dug, and the mixture is compacted by small sheeps-foot rollers working in the trench.*

Ingenuity in adapting everyday trenching equipment to a special task is shown in constructing deep and narrow cut-offs of bentonite-treated loess for 23 earth dams of the Tri-County Project in Nebraska. These dams are a part of the 75-mi. supply canal, sections of which make use of natural dry canyons located along the line; the dams close off ends of canyons. They range from 29 to 74 ft. high and from 300 to 1,200 ft. long and all are constructed of the fine sandy or silty loess soil of the region which is indicated by Fig. 1.

Based on laboratory studies, which are outlined later, it was decided to build a dam with a core trench having a minimum width of 18 in. and a depth of 20 ft. dug at the upstream quarter point, and to backfill the trench with a 95–5 mixture of soil and bentonite compacted to at least natural-ground density. The top two feet of the trench is flared back on 1 on 2 slopes. With trenches of these dimensions the use of trench excavators was naturally indicated; the problem was how to mix the bentonite with the material thrown up by the trench excavator. The project engineers and the contractor solved the problem as follows:

Method of construction

The proper quantity of good quality bentonite of at least 40 mesh fineness is placed in a shallow trench about 2 ft. deep and 18 in. wide, which is dug on the core line ahead of the trencher. The trenching machine then moves at a very slow rate along the line and picks up the bentonite with the soil. Water is added from a sprinkler bar attached longitudinally on the inside of the digging ladder. The chain-of-buckets digging process results in a uniform mixture of soil, bentonite and water in the spoil bank parallel to and on one side of the excavated trench. Without further processing, the excavated material is backfilled into the core trench. Vertical sheeting boards from two to five ft. on centers are used to prevent caving, and are removed just ahead of the backfill operations. It is seldom that there is more than 100 ft. of open sheeted trench between the digging and backfilling operations. This train of operations is clearly indicated in Fig. 1.

The contractor first attempted to compact the soil-bentonite mixture by air tempers, which proved to be a slow and difficult process and to offer some hazard to the men working at the bottom of the trench. The next device, which was developed by the contractor and which has proved very successful, was a unit consisting of two miniature sheep's foot rollers connected in tandem, Fig. 2. The rollers are 19 in. wide and 30 in. high including the feet. The foot face is 1.75 in. square and is 4 in. from the

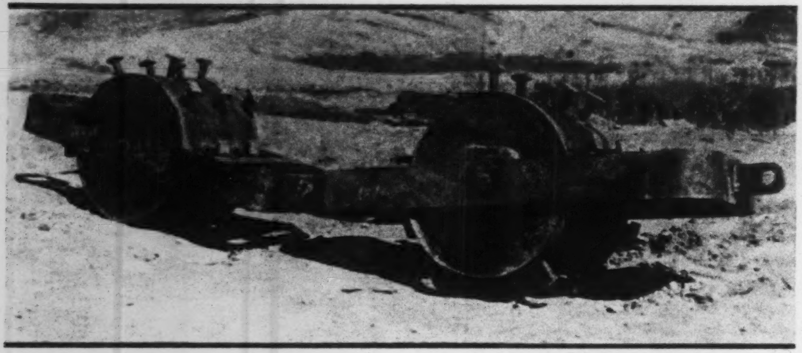

Fig. 2. Tandem sheepsfoot rollers 19 in. wide are pulled up and down the trench to compact the bentonite-treated spoil backfill.

face of the drum. The roller has ten lines of feet evenly spaced circumferentially with two and three feet alternately in each line. The roller is also provided with cleaners both in front and behind. The roller drum is filled with lead to give a total weight of about 1,600 lb.

The backfill is begun by tamping in the backfill by hand, or otherwise from one end of the trench until about a 1 on 1 slope is obtained. The tandem roller is then introduced into the trench on the end of a cable which is attached to a power-driven winch mounted on a tractor or backfilling machine. The soil-bentonite mixture is then dumped into the trench at the top of the slope and the loose material rolls down the face of the slope forming a lift of somewhat uniform thickness. The quantity of material introduced is variable depending on the operation of the rollers; however, the equivalent of from 2 to 4 in. of loose material on the face of the slope is usually introduced at a time. If desired, the rollers may be operated continuously with more frequent introduction of smaller batches.

The movement of the rollers up and down the face of the slope further mixes the material, breaks up the clods which may be present in a small amount and effects the necessary compaction. The slope soon establishes itself under the action of the rollers and remains more or less constant (about 1:1). It has been found that, on the average, two round trips of the rollers (8 single roller passes) on a 4-in. loose lift will give the desired compaction. The rollers run down the slope by gravity and are pulled up by the winch; some braking is necessary to prevent excessive speed on the down trip. The sheeting is removed just ahead of the toe of the backfill slope at the bottom of the trench. An average of about 200 lin. ft. of core trench is excavated and backfilled in an 8-hour shift.

Cutoffs based on tests

The embankment and cutoff design are based on laboratory studies. Scale models of a dam and foundation were constructed in a tank with glass sides and the flow lines determined by a dye trace. The tests revealed that a deep and narrow cutoff is more effective than a broad and shallow compacted core in controlling percolation.

Separate laboratory tests indicated that a mixture of 5 parts bentonite with 95 parts of the loess soil by dry weight would have a permeability of only one-twenty-fifth of that of the natural undisturbed soil at the same density. The tests also indicated that the 95–5 loess-bentonite mixture would compact satisfactorily with a moisture content anywhere from 12 to 20 per cent. At this range of moisture content, it was found that the bentonite did not cause detrimental swelling of the mixture but rather it seemed to give it a mortar-like plasticity that aids compaction.

The narrow cutoff though more effective in controlling percolation, furnishes very little additional resistance to sliding. This was not deemed to be of importance in the construction of these dams as the fine sandy to silty loess, which forms the foundation layer and from which the fills will be constructed, has a high angle of shear, which will furnish plenty of resistance to sliding without the aid of a wide core. The control of percolation was deemed to be of greater importance, consequently, it was decided to use the narrow and deep cut-off trench. The trench was located at the upstream quarter point; this location was predicated on the laboratory tests as well as on other conditions peculiar to the foundation soils.

Men responsible

The works of the Central Nebraska Public Power and Irrigation District commonly known as the Tri-County Project are being constructed under the direction of Geo. E. Johnson, chief engineer and general manager. The construction procedure described was developed by R. E. Dayton, superintendent, C. W. Cunningham, and Walter Scott of the Condon-Kiewit Construction Co. of Omaha, Neb., in conjunction with engineers for the district: L. R. Harvey, A. F. Lepik, R. O. Green, Clarence Wilson, and the writer.

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Municipal Reporting Improved in 1938

Improvement in the reports of cities to their citizens was noted by the International City Managers' Association after an examination of annual reports of 1938. Sample reports of the group showed that cities have turned from mere chronologies of events to explanation of the purposes and methods of operation of their various departments. They describe major steps taken to improve and modernize departmental operations. They attempt to measure results attained, using the best statistical indexes available, but not confining the evaluation to quantitative measures. They work statistics into the text, relating them in proper perspective to the city's financial situation as a whole.

Examples of improved reporting cited by the Association included the report of Fort Worth, Tex., which gave highlights of citizen activity in the city government, showing more than 2,700,000 individual participations in local recreational facilities. Berkeley, Calif., explained to taxpayers the high credit rating of its bonds and the low ratio of bonded indebtedness to assessed valuation. The Portland, Ore., report emphasized the broad objectives of the city plan and the means being used to carry out these objectives.

Steel Piles to Resist Lateral Loads

***Contents in Brief**—Maximum stiffness against seismic movements in the Civic Center Building at San Diego was obtained through the use of steel H-piles in penetrating the deep underlying mud layer. Tests were made to check the actual resistance against the estimates.*

STEEL H-PILES were used in the foundations of the Civic Center building at San Diego to obtain the desired resistance against seismic movements. The building site is on the bay shore where a mud layer 14 to 18 ft. deep overlies the dense, sandy clay into which is was thought necessary to drive the supporting piles. The firm material has a slight slope, and as it was thought desirable to provide resistance to lateral forces of 0.1 g, it became necessary to have the piling carry gravity and lateral loads to the firm ground. Steel piles were required to meet this condition and the point of fixity at the lower end was assumed to be below the level of the top of the firm material. Tests made on the piles after driving checked the design assumptions.

The structure is 546 x 80 ft. in plan, ranges from 2 to 4 stories in height, and includes a tower 150 ft. high. To increase seismic resistance, the tower foundation was excavated directly to the sandy clay in open caisson, and in accord with usual seismic resistant practice, this more deeply founded portion was separated from other parts of the building by an 8-in. open space.

Over the remainder of the building foundation the steel piles, which are all H-sections, vary in length from 32 to 37 ft. and the sizes range from 10-in., 42-lb. to 12-in. 53-lb. sections. A total of 1,521 steel piles were used. Maximum design loads were 30 tons for the 10-in. piles and 40 tons for the 12-in. piles. This included total live and dead loads in the columns and basement floor footing and foundation and tie-beam loads.

Piles were driven with a 5,000-lb. steam hammer using a 30-in. fall. The driving head used was designed to minimize battering and to facilitate turning the pile in the leads. There were no bent webs or flanges and trimming of the top was necessary in only one case.

After driving, tests were made on several of the piles in direct bearing and in bending. In bearing tests, based on 30 tons per pile, 100 per cent dead load and 50 per cent live load was applied in increments of 5 tons, and settlement was measured under each application until the movement in a 15-min. period was less than 0.001 in. Rebounds were measured at frequent intervals by reducing and reapplying the load. The result of direct load tests led to the conclusion that there would be ample margin of safety on the designed loads.

A basis for estimating the point of fixity for resistance to bending was sought by applying lateral force with a pneumatic jack set between the tops of adjacent piles. Force was applied in 500-lb. increments; deflections were measured at each increment of loading and on corresponding decreases. Under these bending tests resistance of the sand fill was lessened by vibrating the pile with an air hammer while the deflection was held constant. While under vibration it was possible to reduce the load in the jacks as much as 40 per cent without lessening the deflection of the pile. It was believed that vibration allowed the sand to redistribute itself around the pile, thus decreasing the support against lateral load. When horizontal deflection curves were plotted it was found that the steepest strain curves were those made while vibrating the pile.

In each test several points were determined, after an initial period of adjustment, at which a pile could be vibrated indefinitely without changing either the pressure or the deflection. These tests led to the conclusion that lateral fixity should be assumed to be 2 ft. below the level of the harder material.

The upper ends of the piles were capped with a steel plate welded to the pile as an aid in distributing the loads throughout the footing. Concrete of connecting tie slabs imbedded the steel piles to a depth of 18 in. Bench marks placed when the piles were driven and observed 18 months after load application, showed no settlement. Two locations in the basement have been provided where observations may be made as to corrosive action on the piling, if any.

The building was designed by J. H. Davies, consulting engineer, Long Beach, Calif., and foundation tests were made with the cooperation of R. V. Labarre, foundation engineer.

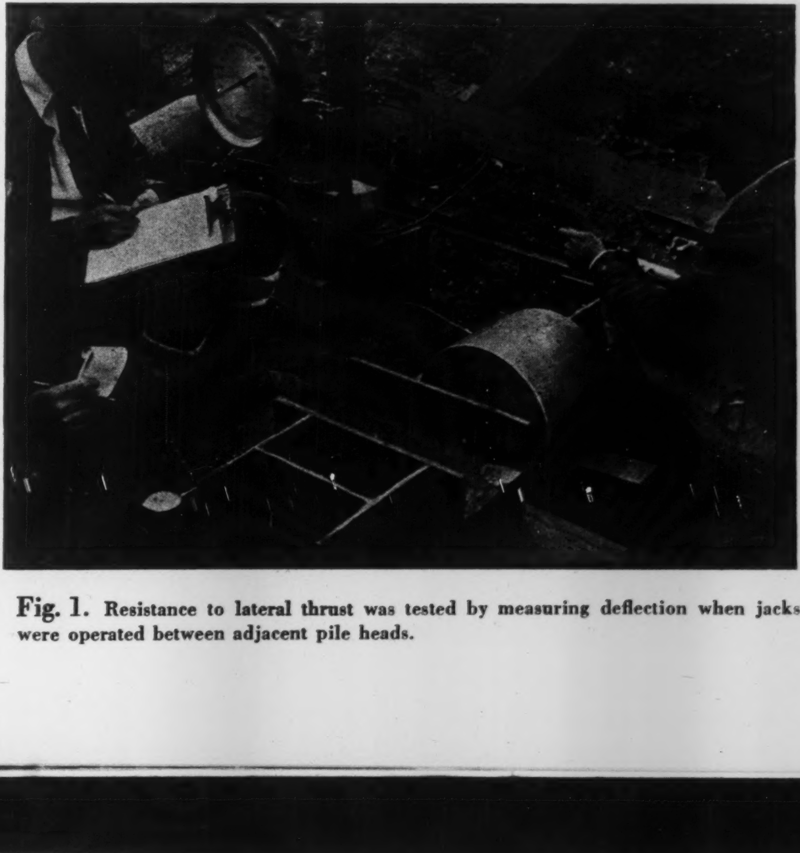


Fig. 1. Resistance to lateral thrust was tested by measuring deflection when jacks were operated between adjacent pile heads.

Concrete Girder Carries 800-Seat Balcony

WILLIAM T. WRIGHT
Structural Engineer, Los Angeles, Calif.

***Contents in Brief**—An uncommonly large concrete girder, used in a high school at Norwalk, Calif., spans 85 ft. and is reinforced with 2-in. square bars rolled in 90-ft. lengths. Girder sections vary from rectangular to T shape, with the stem of the T reducing in thickness toward the center of the span. Timber pile foundations were required to support the concrete forms. The girder was constructed with WPA labor.*

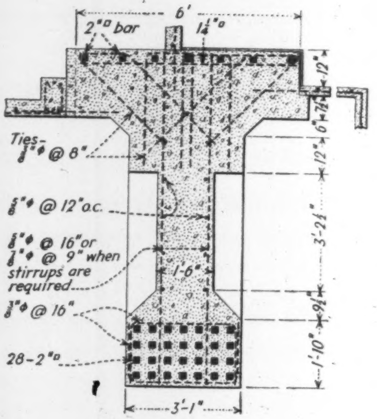


Fig. 1. Section at center of 85-ft. span balcony girder. Near supports girder section is rectangular instead of flanged.

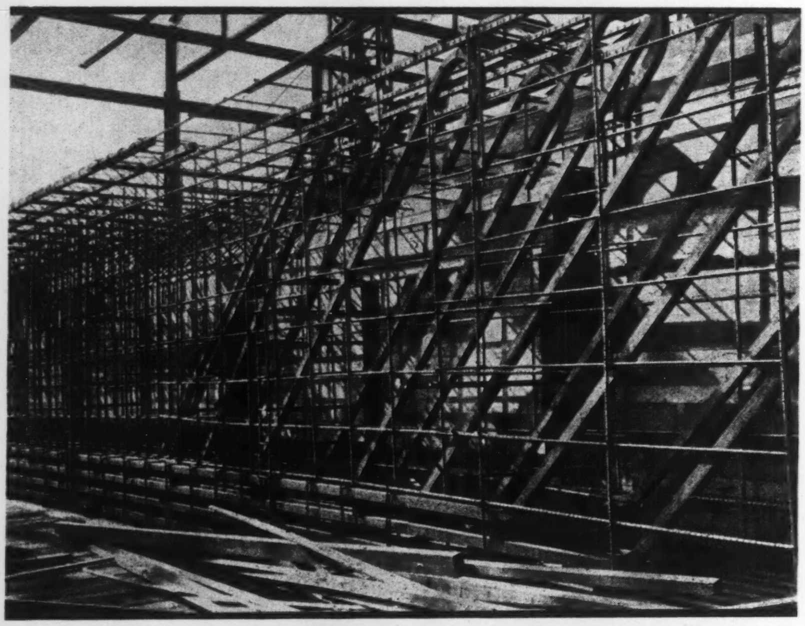


Fig. 2. Principal girder reinforcing consists of 2-in. square bars 90 ft. long. Notched plate spacer racks supported the four layers of bars in proper position until concrete was placed. View shows assembly before closing side form was erected.

A CONCRETE GIRDER 9 ft. deep, of 85-ft. span, and reinforced with 2-in. square, unspliced, plain bars is a feature of the framing for an 800-seat balcony in the new Excelsior Union High School near Norwalk, Calif., not far from Los Angeles. Concrete was chosen for the balcony structure because the construction was to be done by WPA labor, and such a design furnished the maximum amount of job labor. Also, this type of construction resulted in a considerable saving to the school district because the cement was furnished by the WPA.

The balcony structure consists of the master girder and a set of 6 beams cantilevered over it. Details of the girder are shown in Fig. 1, this T-section extending 31½ ft. either side of the centerline; at the ends the section is rectangular with a width of 3 ft. 1 in. The width of the stem of the T is reduced to 2 ft. 4 in., 1 ft. 10 in., and 1 ft. 6 in., respectively, in the "panels" toward the center, with each panel between cantilevers subdivided by a vertical stiffener 8 in. wide.

The lower flange is kept the full 3 ft. 1 in. width for the entire length of the girder to accommodate the tension steel of 2 in. square bars which are held in place by spacer racks made of notched steel plates and spreaders. The spacers are placed 4 ft. apart along the girder and are offset between successive layers of bars so as not to form planes of cleavage through the concrete. One half, or fourteen of the bars, run the full length of the girder, and the other fourteen are bent up at various points into the compression zone as reduction in tensile stress permits and as proper concrete placement allows. Each bar is one continuous piece, without welds or splices, bent at the mill and trucked 15 miles to the job site. The longest bar in the girder is about 90 ft.

Compression steel—2 in. square bars 44 ft. long—is placed in the top flange at the center of the span. Four 1¼-in. square bars are spliced to the 2-in. square bars and continue to the ends of the girder where they bend down into the supporting column. Three other 1¼-in. square bars bend down into the columns at each end to complete the continuity requirements.

Web reinforcement consists of ⅝-in. bars at the center of the span and in sections where stirrups are not required, and of ¾-in. or ⅞-in. bars in sections requiring stirrups. For a distance of 4 ft. 3 in. from the face of the support, the stirrups are in pairs, side by side, providing double the quantity of web reinforcement. The top flange of the girder is tied into the concrete second floor slab, which acts as a horizontal diaphragm to transmit the seismic forces.

The girder supports are combination spiral and rectangular tied columns, 24x44 in. in section, reinforced with sixteen 2-in. square and eleven 1¼-in. square bars arranged in a manner to provide maximum resistance to bending stresses in the column section. The ½-in. spiral and tie steel is stopped at the bottom of the girder, but the vertical bars extend to the top and give rigidity to the girder-column connection.

Construction

Formwork used for this girder during construction was unusual in that it was supported on sixteen 30-ft. timber piles driven in pairs, 4½ ft. apart and about 8 ft. on centers along the centerline of the girder. Falsework on these piles carried a working platform 12 ft. wide to give ample space for the men to work while handling the long and heavy bars and constructing the web forms. The platform was built to conform to the 3-in camber of the girder. After the erection of one side of the form, the stirrups were set in position and laid down as flat as possible so that the heavy bars would not have to be lifted any higher than necessary. These 2-in. square bars were then run up on sloping skids to the working platform and lifted by means of three tackles hung from the steel roof framing overhead. The end lines were connected direct to the bar while the center line came down to a three-point bridle with carrying points about 10 ft. apart.

In concreting, small tremie tubes were used to chute the concrete down between the closely spaced bars to limit the drop, to keep the reinforcing steel clean above the pour level and to distribute the concrete evenly throughout the forms. The concrete placed in the bottom of the stem had part of the coarse aggregate omitted up to the top of the tension steel. Only hand tamping was used in placing the concrete.

Personnel

Drawings and specifications were prepared by T. C. Kistner, architect for the school district, with the writer as structural engineer. Peter M. Black was superintendent of construction for the school district and Lewis K. Osborn resident inspector for both the school district and the architect.

Paved Channel for Flood Control

***Contents in Brief**—A paved channel has been built for the Floyd River through part of Sioux City to increase its capacity and reduce flooding. Methods of construction and details of the concrete channel design are given.*

LINING a mile of good-sized river channel with concrete is a feature of the Floyd River flood control project, begun in December, 1937, at Sioux City, Iowa. The improvement is designed to minimize future flooding from the Floyd River which empties into the Missouri River through an industrial section of the city and which has overflowed three times since 1892 with great property damage and some loss of life. Near its mouth the river is flanked by buildings and receiving yards of Sioux City's extensive packing house district and since flow through this district is confined to a channel 125 to 140 ft. wide, the decision was made to line the first mile to a cross-section of maximum hydraulic efficiency, without disturbing adjacent property, and then to deepen, straighten and enlarge to about a 200-ft. width but not line the next 5½ miles through the residential part of town. The total length of the flood control project is therefore over 6 miles.

The slope of the river is being used practically as it exists—the first mile 0.0006 or about 3 ft. per mile and throughout the unlined section, 0.0003875. The gradient break occurs where a stabilized point seems to have existed for years.

Details of concrete lining

The lining (Fig. 2) consists of:

(1) A 6-in. bottom paving about 110 ft. wide, forming a trough sloping 1:10 toward the center. The slab is reinforced with ½-in. round bars spaced 5 in. each way to minimize cracking in the event of uneven settlement. Rigidity is provided by reinforced concrete beams spaced 75 ft. or less transversely and by four longitudinal beams, all integral with the slab except for separation at transverse expansion joints every 75 ft.

(2) A 6-in. bank pavement with 1:1 slope built monolithic with the bottom pavement and stiffened by continuation of the transverse beams.

(3) Vertical retaining walls of various heights, integral with the bank section and about 140 ft. apart. Maximum wall height of 4 ft. provides for a theoretical 25,000 sec.-ft. flood. The design gives a cross-section area of 2,000 sq.ft. with maximum depth of flow of 20 ft. 6 in. plus retaining wall height as freeboard. The river banks are relatively

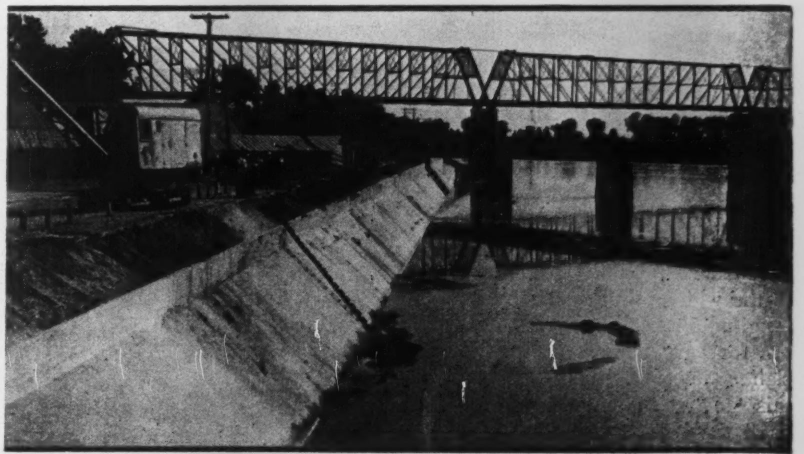


Fig. 1. Completed concrete channel for Floyd River in Sioux City, Ia.

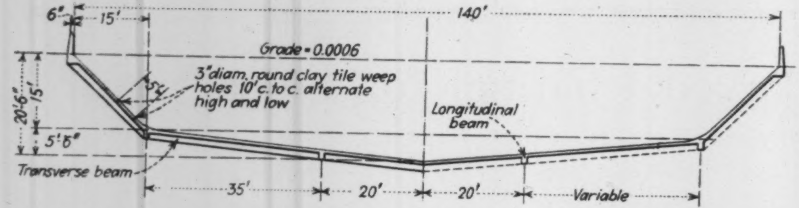


Fig. 2. Design details of the concrete lining placed in the channel of the Floyd River at Sioux City, Ia. as a flood protection measure.

stable, hence the sidewalls do not hold the banks in place but merely increase the hydraulic efficiency of the channel.

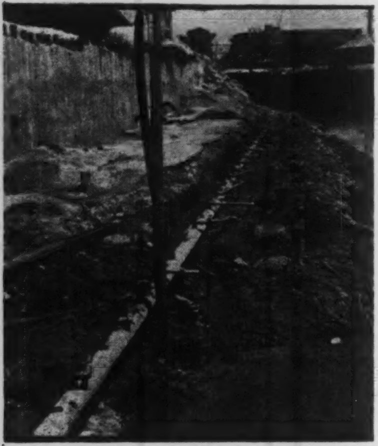


Fig. 3. Well point installation for drying the working area.

Construction procedure

Construction was carried on in 500-ft. sections and is now nearing completion. As the initial step about three-fourths of the channel width is unwatered. Steel sheet piling is then driven parallel to the bank near one side, a narrow diversion channel excavated back of the piling, and flow diverted with earth dams at either end of the section. Drying up the channel is accomplished in about two weeks by means of 3-in. well-points driven 20 ft. in the ground at 4 ft. intervals. Well-point lines are located along the base of either or both banks. About 150 to 175 ft. of channel is concreted at a time, to the width piling will permit. The longitudinal and transverse beams are formed with rough lumber, and slab concrete is placed directly on this subgrade. Concrete is specified as 3,500 lb. per sq.in. at 28 days and is vibrated during placement.

After the full 500-ft. section is placed, flow is returned to the main channel and the remaining cross-section back of the piling unwatered, dried, graded and paved.

Money and men

Construction on both the concrete and the unlined sections is scheduled for completion in 1939. Work to date has been financed with WPA funds of $1,900,000 plus $615,000 from city funds, the city's share including $250,000 for purchase of right-of-way. Proposals have been made for $1,000,000 additional WPA funds to be matched by $300,000 more from the city. It is planned to raise further funds through assessments on abutting and neighboring industrial property.

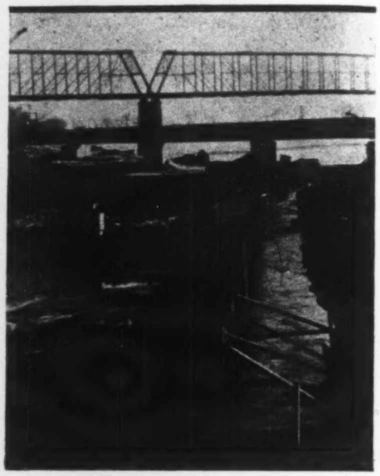
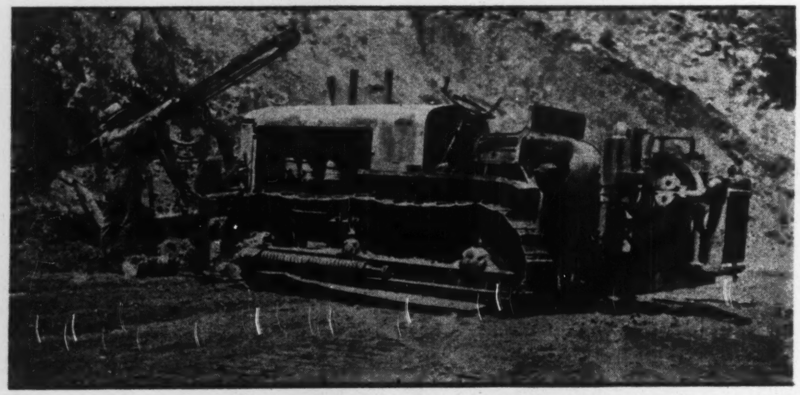


Fig. 4. River bypass channel outside of sheet-pile-inclosed working area.

The project is under the direction of Keyes C. Gaynor, city engineer of Sioux City. The lining was designed by Paul D. Cook, former city engineer. L. P. Staman is resident engineer, C. R. Smith is state field engineer for WPA and P. A. Twohig is WPA superintendent. Moretrench Corp. furnished the unwatering equipment. Alvord, Burdick & Howson, consulting engineers, made the preliminary report upon which the channel design was based. Work is being done by force account.

Tractor Mounted Drill Rig

On channel straightening work incidental to relocating the Southern Pacific Company's line through Soledad Canyon in Southern California, much rock drilling was required in the side slopes of the canyon near streambed level. For this part of the work a very convenient rig was provided by mounting a drill bar on the forward end



Complete drill outfit and compressor mounted on a tractor for speedy movement about the job.

of a tractor to whose rear end a motor-driven compressor unit had been attached.

This rig could move so conveniently from one location to another that high efficiency in drilling was attained on holes scattered at intervals along about 1,000 ft. of the channel. While one set of holes was being cleaned out, loaded and shot, the drill rig could be at work outside the danger zone. The speed and convenience with which the tractor could be moved enabled it to save time frequently in power-shovel operation when hard formation or boulders were encountered. At such times the tractor would quickly move into position and drill a few holes in the formation that required shooting.

The rig was developed by Clyde W. Wood, contractor on the work.

Rubbed in Traffic Stripes

Wm. E. Barker,

Regional Highway Engineer, Portland Cement Association, Atlanta, Georgia

Pigment rubbed into scratched fresh concrete forms indelible traffic line on recent Texas roads

Several recent concrete roads in Texas have traffic stripes formed by colors incorporated in the concrete of the pavement. On straight away a single black stripe is used and on curves and hills two parallel black stripes separated by a yellow stripe. Briefly the pigment is rubbed into the top $\frac{1}{8}$ in. of finished fresh concrete which is roughed up to mix with the color and then is troweled smooth. Black iron oxide is the pigment used for the black striping. The accompanying views show a hilltop stripe and the device with which the striping is done.

All the work is done from a bridge resting on wheels that run on the side forms. The bridge is made of 2-in. water pipe, with cushioned boards paralleling the center line of the pavement, on which the workman kneels to make the stripe. It is moved forward by hand, with either a rotating wheel or a ratchet device with a pipe lever for a handle, geared to the rear wheels. Two angles, held apart the 6-in. that is desired for the width of the line, are lowered to the pavement after the machine is moved forward and before the color is applied. These keep the color from spreading to the concrete outside the traffic line.

The iron oxide is put on dry, as a powder. The finished surface of the fresh concrete is first roughened by scratching it with a small rake, then the color is dabbed on, either with a stick or a tablespoon; is spread with a calcimine brush and then is rubbed into the concrete with a wood hand-float. The color penetrates the concrete to a depth of $\frac{1}{8}$-in. The pavement is cured in the ordinary way, except that a strip of paper is put over the stripe to keep the fresh color from marking mats or burlap and to keep curing water from spreading the color before the concrete has hardened.

About 2 lb. of the iron oxide is used per 100 ft. of traffic line, and in the quantities required for this work, the color costs about 9c per lb. One laborer does all the work, receiving 35c per hour. The equipment costs about $75. For an average daily run of 1,200 ft. of 20-ft. pavement in 10 hr., labor for the permanent center stripe costs $15.40 per mi., color $10.40 and equipment $2, or a total of $28 per mi.

On one project, the contractor constructed a machine, powered with a small gasoline motor, which roughens the pavement and rubs in the color. This increased the equipment cost somewhat but reduced the labor charge to half the time of one man, leaving the total cost about the same.

On curves and hilltops, or wherever limited sight distance make it dangerous to cross the center line a permanent 6-in. yellow line is placed along the center of the slab, with a black line on each side of it.

The idea for this form of permanent traffic line originated with J. D. French, concrete paving engineer, and Jim Douglas, division engineer, Texas highway department, who have applied for a patent; the equipment was developed by various contractors.

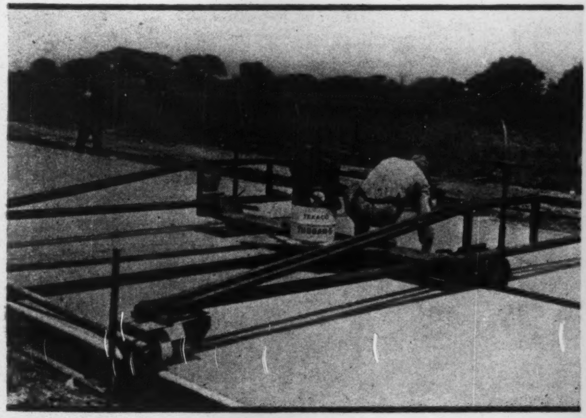


Fig. 1. Striping is done from a staging on wheels; color is confined to the 6-in. width of the stripe by two angles and is dabbed on with a stick or spoon.

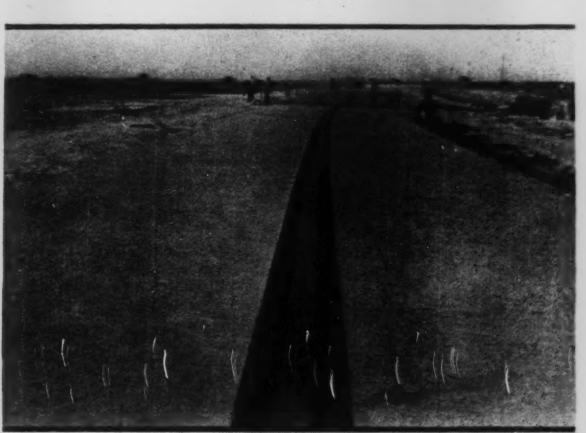


Fig. 2. On curves and hilltops a triple line is installed, having a yellow center and black edges; for the triple line two angles and two flat steel bars are used to confine the color.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Field Test for Soil Density

William S. Foster
Inspector, Iowa Highway Commission, Resident Engineer's Office, Jefferson, Iowa

The accompanying illustration shows the method used by the Iowa highway commission for determining the density of a rolled fill layer. This method is used in particular on stabilized-base construction. In building these bases, it is the practice here to roll the soil to a specified density determined from the Proctor test. In making this rolled density test we follow the procedure outlined below:

After first carefully cleaning an area on the roadbed, we place the tripod, shown in the picture, on three nails and clamp the center movable leg so that it touches the roadbed. Then we remove the tripod and very carefully dig out a sample beneath the spot where this movable leg has been. It is important that this hole be dug carefully and that every particle of the sample be caught and saved. Then we replace the tripod and fill the hole with oil. We carefully pour until the surface of the oil touches the bottom of the adjustable leg. We then take the temperature of the oil poured in the hole so that we can adjust it for volume.

Device used in density test of rolled fill

Knowing the weight of the bottle and oil both before and after test, it is a simple matter to get the weight of the oil poured in the hole, and thereby get the volume. Likewise, knowing the volume and the weight of the sample, the observed density naturally follows. Then, by drying out a portion of the sample to determine the moisture content, one can easily reduce the observed density to dry-density basis. It is on this dry-density basis that the specifications are generally written.

The oil we use is No. 30 motor oil, laboratory tested for specific gravity at various temperatures; we pump it out of the hole with a little hand pump after the test.

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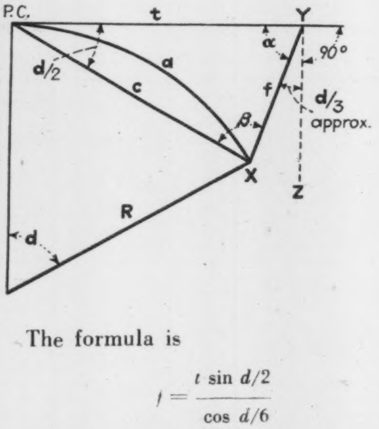
Curve Offset Tables

Robert L. Clifford
State Highway Department, Augusta, Maine

I have made up a set of curve tables that are much quicker to use than are deflection angles, and which give accurate results for highway work. These tables are based on a formula which I derived. The formula is not exact but it is so nearly so that for all practical purposes it may be assumed to be exact.



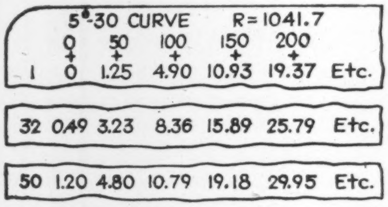
The formula is

$$f = \frac{t \sin d/2}{\cos d/6}$$

and it is based on the fact that the angle *XYZ* (see drawing) is very nearly equal to $d/3$. For example, if *d* is 60 deg., then the angle *XYZ* figures out to be 19 deg. 59 min. instead of 20 deg., but the small deviation of this angle makes but very little difference in the value of *f*.

Practically all the curves run last summer on state aid and federal aid secondary roads in this state, were run by these tables. We had photostatic copies made and pasted them into time books for field use.

The tables are easy to use because the offsets to the fifty foot stations of a curve from one sub tangent are all on one line. For example, *PS* = Sta. 6+18, and *D* = 5 deg. 30 min. Then Sta. 6+50 is 32 ft. or 0+32 ft. from the *PC*. Sta. 7+0 is 82 ft. or 50+32 ft. from the *PC* Sta. 7+50 is 132 ft. or 100+32 ft. from the *PC*, etc. and the offsets appear in the tables, a partial facsimile of which is shown below.



5°-30 CURVE R=1041.7

	0+	50+	100+	150+	200+	
1	0	1.25	4.90	10.93	19.37	Etc.
32	0.49	3.23	8.36	15.89	25.79	Etc.
50	1.20	4.80	10.79	19.18	29.95	Etc.

The complete tables include curves at 30 min. intervals from 0 deg. 30 min. to 6 deg.; at 1 deg. intervals from 7 deg. to 16 deg.; and 18 deg., and 20 deg. curves.

• • •

Base Areas of Stockpiles

Leonard A. Deklotz
U. S. Bureau of Public Roads, Portland, Ore.

If one has many stockpiles to build the following formula for determining base areas may be quite useful. Side slopes of $1\frac{1}{4}$:1 are assumed as most crushed material stands on that or a steeper slope.

V = Volume in cu.yd.
h = Height in yd.
A = Area of base in sq.yd.

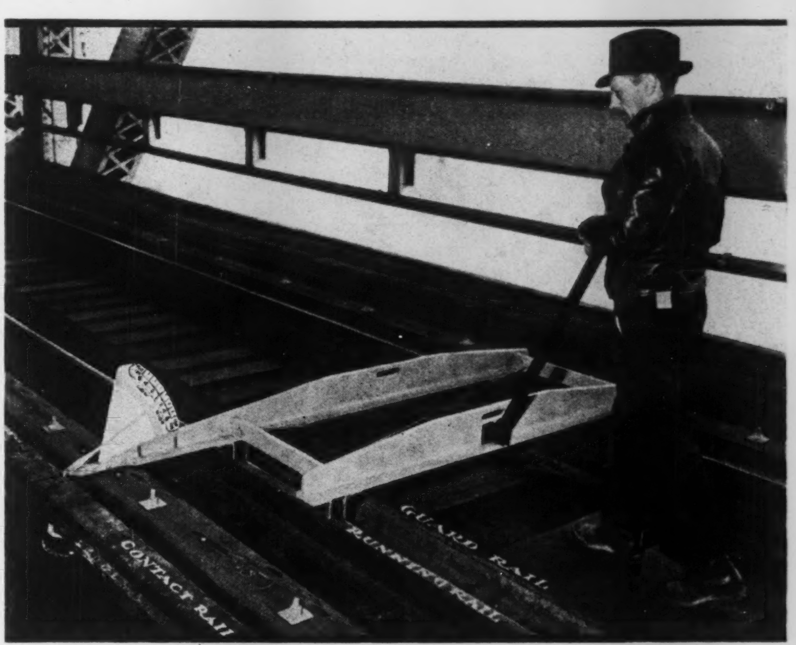
$$A = \left(\frac{2.5h + \sqrt{\frac{4V}{h} - 2.08h^2}}{2}\right)^2$$

This formula may be used for piles of any shape without serious error as long as the ratio of base length to width is not excessive. It should also be noted that the width of the base should not be less than 2.5 *h* plus minimum width of the top of the pile.

Contact Rail Gage

A contact rail gage, designed by L. V. Cantrell, state inspector of the construction of the San Francisco-Oakland Bay Bridge electric railway system, performs four functions: (1) checks the gage of the running rail; (2) checks the height of the protection timber above the contact rail; (3) checks the horizontal distance from the running rail to the protection timber, and (4) checks the height of the contact rail above the running rail.

A variation of 0.01 in. of the contact rail above or below its allowed distance from the running rail is clearly indicated on the gage. This consists of two parallel straight edges on 2-ft. ecnters, cross-braced and held rigid to each other. Each straight edge is a gage for the running rail. Between the pairs of steel angles, fastened to the four corners of the gage, are small ball-bearing steel wheels, on which the gage runs. One of the straight edges extends beyond the running rail and forms a bearing for the shaft which supports the contact rail wheel and a fulcrum for the contact rail indicator. The indicator is 16 in. long and the contact rail wheel is 1½ in. in diameter, with $\frac{1}{16}$ in. bearing. The weight of the machine is about 50 lb.; the dial on the contact rail gage is graduated to $\frac{1}{16}$ in.



A versatile rail gage for electric railway inspectors

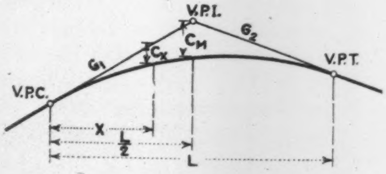
• • •

Simplifying Tangential Corrections

Herbert W. Witte

Engineering-Draftsman,
Georgia State Highway Department,
Atlanta, Ga.

In the office preparation of highway and railroad grading plans, the customary procedure is to calculate tangential corrections to parabolic vertical curves with a calculating machine. When such a machine is not available, as is frequently the case on construction, a simple, rapid and accurate method of making these computations on a slide rule is desirable.



The usual fundamental equation for the tangential correction at the V.P.I. is:

$$C_m = \frac{(G_1 - G_2)}{8} L, \qquad (1)$$

where $G_1 - G_2$ the algebraic difference in grades, expressed as a percent, hereinafter referred to as D; L = the length of the curve in stations.

Also, the correction at any point on the curve is represented by the equation:

$$C_x = \frac{x^2}{\left(\frac{L}{2}\right)^2} C_m, \qquad (2)$$

where x is the distance in feet measured from either the V.P.C. or the V.P.T.

By combining equations (1) and (2) and simplifying, the following general relation is established:

$$Cx = \frac{0.0001\, D\, x^2}{2L} \qquad (3)$$

The simplest slide rule solution of this formula involves the use of the A, B, and C scales, and in most cases a single setting of the slide is sufficient for any one curve regardless of the number of intermediate corrections to be determined. To D on the A scale set $2L$ on the B scale, and retain this setting. The glass indicator slide can now be progressively set to values of x on the C scale and the corresponding value of C_x read directly above on the A scale.

The decimal point may be readily applied to the result by sight. The factor 0.0001 does not, therefore, enter into the actual calculation. Normal accuracy of the slide rule will insure results correct to the nearest hundredth of a foot, as is usually required.

If the values of x are taken progressively from either the V.P.C. or the V.P.T., the corrections for the entire vertical curve may be computed with a minimum of effort and a maximum of efficiency. Note that when x is equal to $\frac{L}{2}$ the formula then reverts back to the equation (1).

• • •

Deep Soil Auger Holes

E. B. Van de Greyn

Bridge Engineer, New Mexico Highway Department, Santa Fe, N. Mex.

We have made soil explorations in clay, gumbo and tight sandy formations which will not cave by boring holes with a large auger. The equipment consists of a 12-in. diameter auger with a 1-in. shaft using 5-ft. lengths of 1-in. pipe for extending the shaft; the sections are threaded at both ends and at the top is a tee for inserting a rod for turning the auger. If holes are carried deeper than about 12 ft. a small A-frame with block and falls is used to lift the auger with its load of dirt. In dry holes where the borings crumble and slip out of the auger it is necessary to pour small amounts of water into the hole to make the material stick in the auger. Holes have been bored to a depth of 25 ft. This equipment is not satisfactory in gravel formations. The auger is shown in the catalog of Monsen-Dunnegan-Ryan Co. of El Paso, Tex., under the term Iwan. The auger costs about $6 and the pipe for extension about 50c. per foot.

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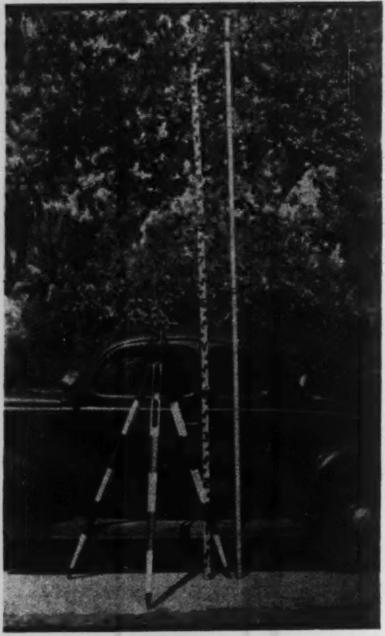


VISIBLE TRIPOD LEGS

The illustration shows the legs of a tripod painted alternate red and white like a line pole. This catches the eye of autoists on city street work, greatly increasing safety, and in the woods or brush the instrument is very much easier to see than are natural colored tripods. The darker color should be placed at hand contact points.—THOS. MADDOCK, *Phoenix, Ariz.*

• • •

Water Services at Intersections

Records of water mains, valves and hydrants at street intersections for the Indianapolis Water Co. placed on 5x8-in. cards are made by the engineering department for each intersection covered by the distribution system. No scale is used but all details of the mains and other equipment are shown, as well as all private connections, other than small services. It is the job of the map draftsman to post new information on the cards monthly. After completion and checking three blueprint sets were originally distributed to the distribution and transportation department and another three sets to the construction department. Additional or corrected cards are distributed annually. These cards are from the standard practice manual as noted in *ENR* Sept. 8, p. 302, for all repetitive items involved in company operation.

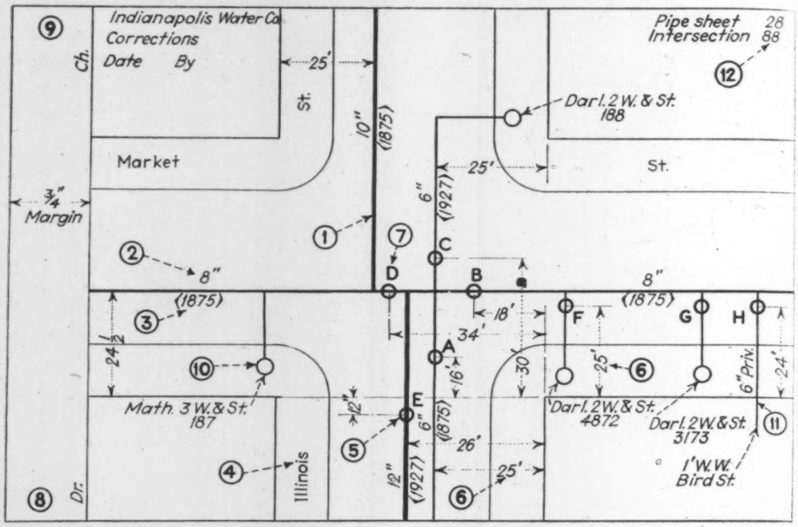

Indianapolis Water Co.
Corrections
Date By
Pipe sheet 28
Intersection 88
Ch.
St.
Market
St.
Dr.
Illinois
¾" Margin
25'
10"
(1875)
6"
(1927)
8"
(1875)
Darl. 2 W. & St. 188
Darl. 2 W. & St. 4872
Darl. 2 W. & St. 3173
Math. 3 W. & St. 187
1' W.W. Bird St.
6" Priv.
A
B
C
D
E
F
G
H
18'
34'
16'
30
25'
24'
24½
12"
26'
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫

Fig. 1. Items shown by numerals on 5x8-in. cards are as follows: 1. weight of lines for mains from 6 in. to 36 in.; 2. size of mains; 3. date main laid; 4. street names; 5. size of valve; 6. distance from property line; 7. valve number; 8. drawn by; 9. checked by; 10 hydrants—make, type, number; 11. private lines, and 12. pipe sheet and intersection number.

• • •

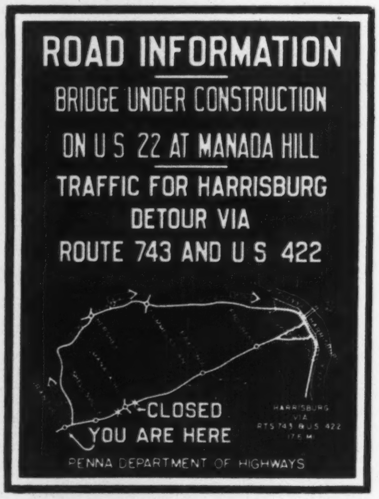
Brief Memoranda

Emergency gates in the outlet tunnels at Fort Peck dam, closed to keep water out while installing the regular control gates, were made watertight by dumping cracked wheat above the closed gates. The wheat is carried by the water into any small spaces between the gate and the gate seat and there swells to close any leak.

• • •

Improved Detour Sign

Pennsylvania is trying out a new system of detour marking illustrated by the accompanying drawing. Primarily the marking is designed to aid the stranger to the road and the through traveler. By map and lettering the sign, large enough to be easily read, tells the motorist where he is, where the old road goes and to what point on his route the detour will take him. In addition signs at the ends of the detour will tell him how long it is and how many miles of the road are improved, how many are unimproved and how heavy a load the bridges are safe to carry. On the map the closed part of the old road is painted red on white but all other parts of the map and all signs are black on white. While local traffic is in position to know how to distribute itself within the territory affected by the closed road, signs enough are provided to keep it warned. The new detour marking plan was developed by the Pennsylvania department of highways, Samuel W. Marshall, chief engineer.


ROAD INFORMATION
BRIDGE UNDER CONSTRUCTION
ON U S 22 AT MANADA HILL
TRAFFIC FOR HARRISBURG
DETOUR VIA
ROUTE 743 AND U S 422
←CLOSED
YOU ARE HERE
HARRISBURG
VIA
RTS 743 & U S 422
17.6 MI
PENNA DEPARTMENT OF HIGHWAYS

Pennsylvania detour sign carries a map

Test Pit Timbering and Tools

E. B. Van de Greyn

Bridge Engineer, New Mexico Highway Department, Santa Fe, N. Mex.

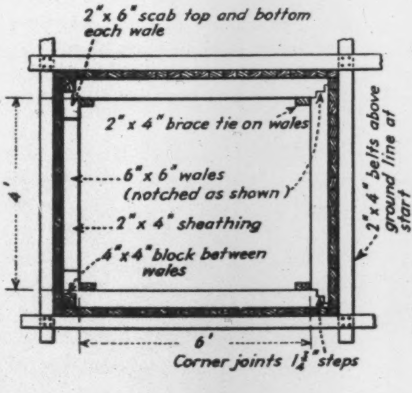
No sounding or boring quite supplants the test pit in predetermining the ground conditions that the foundation builder will meet in his operations. And where depths and other conditions are not prohibitive, test pits are used in subsoil explorations for road bridge foundations by the New Mexico state highway department engineers.

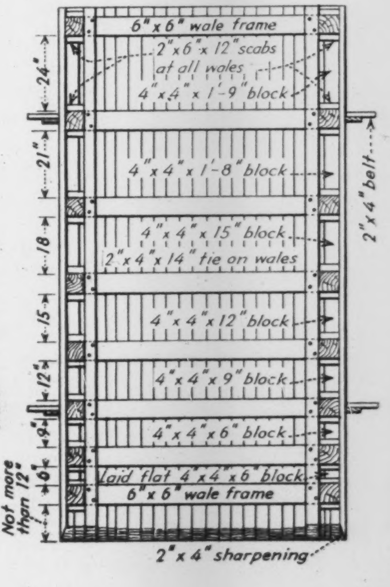
A pit about 4 x 6 ft. in which men can work without being cramped is desirable and in non-caving ground this can be dug about 9 ft. deep with no other tools than picks and shovels. For deeper pits, whether open or sheeted, a windlass or an A-frame, with rope and pulley, or a power hoist, is required to lift the excavated material.

In dry pits in caving soils and in wet pits sheathing is necessary, and the construction shown by the accompanying drawings is used. The materials required for the 14-ft. depth shown are a little over 1,500 F.B.M. If a single line of sheeting is not sufficiently sand or water tight, use two lines or a Wakefield sheetpile assembly.

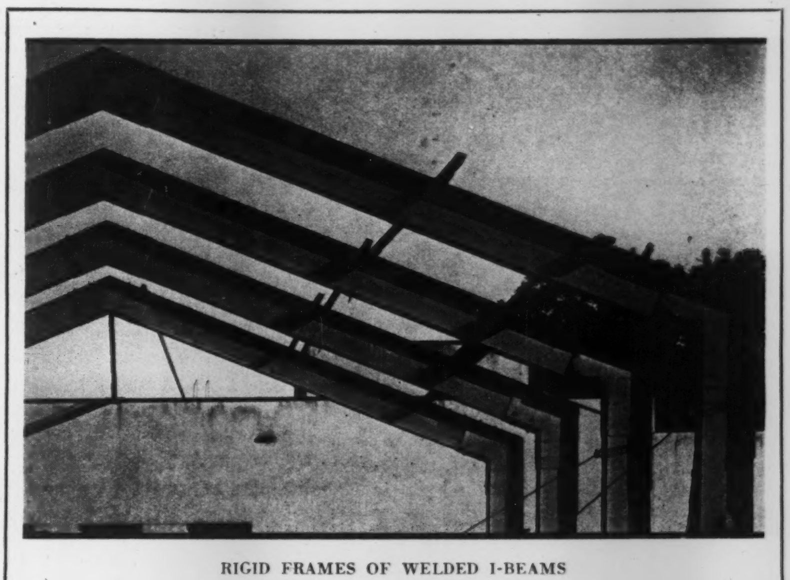
For open pits, picks and shovels are the only tools required; for timbered pits as described there must be added a saw, a square, a 5-ft. bar and sledges and hammers. In pits wet enough to require pumping, any of the following types of pump that is available can be used: (1) A No. 3 diaphragm pump with 3½-in. suction hose 13 ft. long. This pump will take care of most of the ordinary flows of water coming into a 4x6-ft. test pit; (2) a 3-in. centrifugal pump direct connected to a Model A Ford engine and mounted on skids, with 13 ft. of suction hose with a foot valve attached; (3) a 4-in. Novo centrifugal pump direct connected to the engine and mounted on rubber tired trailer with a 20-ft. suction hose; (4) a 4-in. centrifugal pump, with 13 ft. of suction hose with a foot valve, belt driven from a Fordson tractor power take-off; (5) an 8-in. centrifugal pump, with a 15-ft. suction hose with foot valve, driven by belt from a Fordson tractor power take-off.

All the centrifugal pumps noted are equipped with gate valves at the discharge ends to regulate the amount of discharge to the inflow of water into the pit, so that the pump will not lose its prime. A pipe tee with plug is placed between the pump and the gate valve to permit water to be poured into the pump to prime it, except the 4-in. Novo which is self-priming. In general a power pump larger than 4 in. has not been needed. The equipment noted can be secured from any large equipment supply company.


2"x 6" scab top and bottom each wale
2" x 4" brace tie on wales
6" x 6" wales (notched as shown)
2" x 4" sheathing
4"x 4" block between wales
2"x 4" belts above ground line at start
4'
6'
Corner joints 1¼" steps


6" x 6" wale frame
2" x 6" x 12" scabs at all wales
4" x 4" x 1'-9" block
4" x 4" x 1'-8" block
4" x 4" x 15" block
2" x 4" x 14" tie on wales
4" x 4" x 12" block
4" x 4" x 9" block
4" x 4" x 6" block
Laid flat 4" x 4" x 6" block
6" x 6" wale frame
2" x 4" sharpening
2" x 4" belt
24"
21"
18
15
12"
9"
6"
Not more than 12"

Standard test-pit timbering used by the New Mexico state highway bridge department.



RIGID FRAMES OF WELDED I-BEAMS

Frank I. Jones
Portland, Ore.

I-beam wall columns and rafters welded into rigid frames were used as illustrated in building the new east room of the Art Museum, at Portland, Ore. The rafters rise 10½ ft. in a span of 47 1/3 ft. and are supported on columns 32 ft. high. The frames are on 11½-ft. centers. Both columns and beams are 24-in. 100-lb. I-beams. The connections are made with ⅜-in. plates welded to each side of the web and ½x8-in. straps welded to the inner and outer flanges. All the steel is to be encased in concrete. These rigid frames were designed by Miles K. Cooper, structural engineer, Portland, for A. E. Doyle & Associates, the architects for the museum. The steel was erected by L. H. Hoffman, Portland, general contractor.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

SANITARY SEWER, MISSOURI

OWNER: Webster Groves Sanitary Sewer District: W. H. Brown, secretary; W. W. Horner, engineer.

PROJECT: Construction of a lateral sewerage system in Webster Groves south of Big Bend Boulevard between Laclede Station and Edgar Roads, to connect with main trunk sewerage system of the general district. Sewerage as follows: 17,934 ft. of 8-in. vitrified clay pipe in earth and 11,746 ft. in rock; 685 ft. of 10-in. in earth and 335 ft. in rock; 889 ft. of 12-in. in earth and 494 ft. in rock; 2564-ft. of 15-in. in earth and 1755 ft. in rock; 136 ft. 18-in. in earth, and 100 ft. of 6-in. in rock. Stipulated contract time is 180 days. Transportation is by truck to the job.

BIDS: Six bids were received Oct. 14, 1938, ranging from the contract low of $61,222 to $78,969. Minimum labor rates are as follows: skilled, $1.50 per hr.; common, 80¢ per hr.

LOW BIDDERS:

1. Martin & Reilly Construction Co., St. Louis (contract)	$61,222
2. R. C. Micotto Construction Co., St. Louis, Mo.	61,239
3. R. A. Perkinson & Son, St. Louis	69,565

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Cl. "A" excav. rock	810 c. y.	$8.50	$6.00	$8.50
2. Cl. "B" excav	19,220 c. y.	.90	.90	1.10
3. 8-in. V.C.P. in earth	17,934 l. f.	.58	.60	.50
4. 8-in. V.C.P. in rock incl. cradle	1,746 l. f.	.68	.68	1.00
5. 10-in V.C.P. in earth	685 l. f.	.69	.75	.80
6. 10-in. V.C.P. in rock incl. cradle	335 l. f.	.82	.80	1.25
7. 12-in V.C.P. in earth	889 l. f.	.81	.90	1.00
8. 12-in. V.C.P. in rock incl. cradle	494 l. f.	.96	.93	1.30
9. 15-in. V.C.P. in earth	2,564 l. f.	1.14	1.30	1.20
10. 15-in. V.C.P. in rock incl. cradle	1,755 l. f.	1.33	1.33	1.60
11. 18-in. V.C.P. in earth	136 l. f.	1.48	1.60	1.50
12. 6-in. V.C.P.	100 l. f.	.30	.35	.45
13. 6-in. Y junctions on 8-in.	450 ea.	.58	.80	1.00
14. 6-in. Y junctions on 10-in.	33 ea.	.79	1.00	1.50
15. 6-in. Y junctions on 12-in.	39 ea.	1.00	1.50	2.00
16. 6-in. Y junctions on 15-in.	82 ea.	1.62	2.25	2.50
17. 6-in. Y junctions on 18-in.	1 only	2.24	3.00	3.00
18. 6-in. pipe stubs in manholes, incl. stoppers	90 ea.	.36	.60	.75
19. 8-in. pipe stubs in manholes, incl. stoppers	8 ea.	.98	1.25	1.50
20. 8-in. pipe tees, incl. stoppers	17 ea.	1.65	2.00	2.00
21. 15-in. pipe tees, incl. stoppers	2 ea.	6.60	5.00	10.00
22. 8-in. pipe elbows	17 ea.	1.14	1.60	2.00
23. 15-in. pipe elbows	2 ea.	3.22	5.00	7.50
24. 6-in. V.C. regulation bends.	10 ea.	.80	1.75	1.50
25. 8-in. V.C. regulation bends.	5 ea.	1.14	2.50	2.00
26. 10-in. V.C. regulation bends	5 ea.	1.56	3.50	3.00
27. Common brick masonry in manholes	9,600 c. f.	.80	1.00	.90
28. St. cast iron manhole frames and covers	113 sets	11.00	14.00	15.00
29. C.I. manhole steps for holes	528 ea.	.27	.45	.40
30. Restoration of bit. pav	2,400 s. y.	1.80	1.50	2.50
31. Restoration of conc. pav	140 s. y.	2.50	2.25	4.00
32. Lumber ordered left in place	100 M.b.m.	25.00	25.00	35.00
33. Cl. "B" Conc	15 c. y.	10.00	12.50	15.00
34. 8-in. C.I. pipe	72 l. f.	7.50	2.00	2.50
35. 15-in. C.I. pipe	50 l. f.	10.00	3.50	3.50

HIGHWAYS, TEXAS

OWNER: Texas State Highway Department. H. P. Stockton, Engineer.

PROJECT: Construction of 11.012 mi. of road, including structures on U. S. 190 in Bell County.

BIDS: Eight bids were received Nov. 18, 1938, ranging from $202,515 to $230,000.

LOW BIDDERS:

1. Austin Bridge Co.	$202,515
2. Ben Sira & Co.	207,399
3. T. M. Brown & Son	216,348

Item	Quan.	Unit prices		
		(1)	(2)	(3)
1. Clear, grub	14 ac	$85.00	$250.00	$100.00
2. Com. road excav.	99,631 c. y.	.16	.19	.18
3. Sp. road excav.	62,439 c. y.	.16	.19	.25
4. Rock road excav.	24,655 c. y.	.65	.55	.60
5. Com. & sp. borrow (waste)	5,910 c. y.	.10	.12	.15
6. Com. & sp. borrow	17,051 c. y.	.16	.21	.20
7. Com. & sp. borrow	22,899 c. y.	.21	.26	.25
8. Com. channel excav.	14,713 c. y.	.20	.20	.18
9. Sp. channel excav.	3,350 c. y.	.20	.25	.30
10. Rock channel excav.	737 c. y.	1.00	1.00	1.00
11. Uncl. str. exc. culvs.	1,214 c. y.	2.50	1.00	2.00
12. Com. str. exc. brs.	1,119 c. y.	2.50	2.25	2.00
13. Rock str. excav. bridges	277 c. y.	5.00	3.50	4.00
14. Blading embank.	1,207 hr.	2.50	3.00	3.00
15. Sledging embank.	810 hr.	.55	.60	.60
16. Overhaul	19,204 y.qtr.	.09	.12	.10
17. Overhaul (selected mtl.)	58,139 y.qtr.	.09	.07	.10
18. Sprinkling	2,042 M.gal.	1.25	.60	1.00
19. Rolling	727 hr.	2.00	2.50	2.50
20. Cl. A conc. culverts	2,287 c. y.	18.50	19.20	19.00
21. Cl. A conc. bents & abuts.	580 c. y.	21.90	20.75	20.00
22. Cl. A conc. (grdrs. & slabs)	961 c. y.	21.90	20.75	20.00
23. Reinf.	678,155 lb.	.041	.04	.04
24. Gray iron castings	44,068 lb.	.05	.05	.10
25. Cast steel bearing plates	25,950 lb.	.15	.12	.15
26. Structural steel	16,503 lb.	.10	.10	.10
27. Removing old strs.	13 ea.	50.00	9.00	15.00
28. Railing sp	1,680 l. f.	3.25	2.50	3.00
29. Common mortar riprap	135 c. y.	9.00	7.50	10.00
30. Grouted riprap, type A	59 c. y.	9.00	10.00	10.00
31. Dry Riprap, type A	712 c. y.	4.50	3.50	4.50
32. Pipe underdrains	6,500 l. f.	.75	.75	.75
33. Trench sodding	27,564 s. y.	.10	.06	.06
34. Rock retards	265 c. y.	3.50	8.00	4.00
35. Right-of-way markers	250 ea.	1.00	1.00	1.50
36. Rolling	394 hr.	1.50	3.00	2.50

MISSOURI RIVER BRIDGE, NEBRASKA AND MISSOURI

OWNER: Commissioners of Richardson County, Nebr.; R. Daggett, Fall City; Harrington & Cortelyou, Kansas City, Mo., engineers.

PROJECT: Construction of a new bridge at a new site over the Missouri River at Rulo, Nebr. Rulo is in the extreme southeast corner of Nebraska; the site connects the northwestern part of Missouri.

BIDS: Bidding took place Nov. 7, 1938. For contracts No. 1, including earthwork and piers and abutments, three bids were received; on contract 2, part of steelwork, two bids were received; on contract 3, remainder of steelwork, three bids were received; on contract 4, steel erection, floors, etc., two bids were received. Labor rates are as follows: skilled, $1.25 per hr.; semi-skilled, 60¢ per hr.; common, 50¢ per hr.

CONTRACT 1.

Bidders:

1. Kansas City Bridge Co. and Missouri Valley Bridge & Iron Co.	$339,672
2. The Massman Construction Co., Kansas City, Mo.	385,021
3. Keliher Construction Co., Dallas	411,665

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Mass conc. in bases of pneumatic piers 1–3	4,410 c. y.	$40.60	$53.25	$57.00
2. Untr. timber piling in foundation pier 4	3,150 l. f.	1.50	.90	1.00
3. Mass in base of pier 4	360 c. y.	30.00	30.00	26.70

(*Contract Unit Prices continued on second following page*)

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Water Supply

WATER SUPPLY AND PURIFICATION —By W. A. Hardenbergh. 458 pp. Published by the International Textbook Co., Scranton, Pa. Price $4.

Here is an up-to-date compendium on water supply and purification practice written by a man who has not lost the common touch. Primarily, it is designed to meet the needs of the student who wishes to familiarize himself with present day theory and practice. But this in no way detracts from its usefulness to the practising engineer who has not yet reached the "expert" stage. All phases of the subject of water supply are covered in concise, understandable fashion. Illustrative examples are effectively used to show the application of design theory to practice. And a step-by-step procedure in designing the various units of a purification plant serves as a fitting conclusion to the discussion on treatment methods.

Structural Aluminum

STRUCTURAL ALUMINUM—196 pp. Published by the Aluminum Co. of America, Pittsburgh, Pa. Price $1.25.

In each of the fifty years since Charles M. Hall invented a practical process for obtaining metallic aluminum, the material has benefited from improvements which have widened its scope of usefulness. In the past decade especially, research in the field of aluminum alloys has aided the structural engineer. Progress was great enough that by 1930 the Aluminum Company of America issued its first "Structural Aluminum Handbook," modeled on the steel handbooks that are as much a part of the structural engineer's tool kit as a slide rule. The second edition of the "Structural Aluminum Handbook" now issued brings the design and fabrication information up to date. It contains 200 pages as compared with 100 in the first edition. It presents for the first time fundamental information on the ultimate strength of structural members fabricated from aluminum. Its section on characteristics, manufacture and fabrication has been enlarged, and a section on commercial sizes, tolerances and specifications has been added. Tables of elements of sections are made more complete. Since applications of aluminum alloys to structural and architectural purposes is constantly expanding, the importance of this book to designing engineers is obvious.

About Railroads

THE BIG FOUR—By Oscar Lewis. 418 pp. Published by Alfred A. Knopf, New York and London. Price $4.50.

THE RAILWAY AGE—By C. B. Andrews. 143 pp. Published by Country Life, Ltd., London; The Macmillan Co., New York. Price $3.

"The Big Four" is the story of Collis P. Huntington, Leland Stanford, Mark Hopkins, Charles Crocker and of the building of the Central Pacific, according to the title page of the book. But for engineers the book contains one more biographical record of special interest, that of Theodore D. Judah, enthusiastic promoter of a railroad to the Pacific and chief engineer of the Sacramento Valley Railroad, forerunner of the Central Pacific. His was a hard and short life; he wore himself out struggling with men who were essentially promoters and who knew little and cared less for the hard facts of engineering. Judah broke with the "Big Four" over their letting fat construction contracts to dummy companies that they controlled, went to New York to try to find Eastern capitalists who would buy out the "Big Four" and died of yellow fever contracted while passing through Panama.

Much of the story of the building of the Central Pacific is concentrated in the sections on Judah and Crocker, but lesser details and later financial matters are scattered through the whole book.

"The Railway Age" is not a biographical record of our contemporary publication of that name, as Americans might imagine. It is a British book which in a sketchy but well-written manner tells of the early days of railroad building and use in England. The book is very freely illustrated, chiefly with fine reproductions of old drawings, posters, etc.

Terms Used by Engineers

ENGINEERING TERMINOLOGY — By Victor J. Brown and Delmar G. Runner. 310 pp. Published by Gillette Publishing Co., Chicago. Price $3.50.

This book lays the foundation for what ultimately should be a large and very useful dictionary, one in which the many terms used in engineering work are clearly defined. The need for such a special dictionary is urgent in the case of common words which have two or more meanings, one of which is applied only to engineering work. Ordinary dictionaries generally do not give the latter meaning. Take the word "tie", for example, which has a special meaning in surveying work and still another for the railroad engineer.

Included in the book are two appendices of English-Spanish highway nomenclature, an amplification of one prepared originally by the Am. Road Builders' Assn., definitions of surveying terms, prepared by the Am. Soc. of C. E., and a table of abbreviations of engineering terms.

Design Methods

STRUCTURAL DESIGN—By Hale Sutherland and H. L. Bowman. 400 pp. Published by John Wiley & Sons, New York, Chapman & Hall, London. Price $4.50.

The book is intended to follow "Structural Theory" by the same authors. To make profitable use of it a knowledge "more than superficial" is presupposed of statics, strength of materials and structural theory. With this knowledge, this book is a fitting supplement to any textbook on structural engineering. The engineer in active practice as well as the student outside of college walls will find in its pages much of interest and value.

The twelve chapters are respectively entitled: Beams, Columns, Bolts and Rivets, The Plate Girder, Rolled Beam and Plate Girder Deck Railroad Bridges, Half-Through Plate Girder Railroad Bridges, Through

(Continued on p. 84)

(*Continued from page 74*)

4. Conc. in shafts of piers 1 to 4	2,470 c. y.	30.00	25.00	30.70
5. Creo. timber piling in foundations for all other piers and abutments	8,610 l. f.	1.65	1.40	1.50
6. Conc. in bases of all other piers and of abutments.	520 c. y.	17.50	30.00	30.20
7. Conc. above bases in all other piers and in abutments	550 c. y.	37.30	30.00	30.70
8. Reinf. in all piers and abutments	160,000 lb.	.06	.05	.055
9. Grading west approach	18,000 c. y.	.36	.50	.35
10. Grading east approach	7,000 c. y.	.36	.50	.35
11. All pavement on approaches	2,600 s. y.	2.70	2.75	2.75
12. Guard rails on approaches.	1,200 l. f.	1.30	2.50	1.25

CONTRACT 2.

Bidders:

1. Kansas City Bridge Co. and Missouri Valley Bridge & Iron Co.	$112,350
2. Bethlehem Steel Co., Bethlehem, Pa	112,720

Item	Quan.	UNIT PRICES (1)	(2)
1. All pins, pin nuts, shoe, castings, and base slabs for rocker shoes and all castings at stringer expansion joints	47,000 lb.	$0.11	$0.103
2. All other metal work included in this contract	2,330,000 lb.	.046	.0463

CONTRACT 3.

Bidders:

1. Monarch Engineering Co., Falls City Neb.	$33,095
2. Kansas City Bridge Co. and Missouri Valley Bridge & Iron Co.	35,045
3. Bethlehem Steel Co., Bethlehem, Pa	36,975

Item	Quan.	UNIT PRICES (1)	(2)	(3)
1. All pins and pin nuts, shoe castings and base slabs for expansion shoes	22,000 lb.	$0.11	$0.11	$0.1125
2. All other metal work included in this contract.	750,000 lb.	.0409	.0435	.046

CONTRACT 4.

Bidders:

1. Bethlehem Steel Co., Bethlehem, Pa	$127,587
2. Kansas City Bridge Co. and Missouri Valley Bridge & Iron Co.	137,985

Item	Quan.	UNIT PRICES (1)	(2)
1. Handling, erecting and painting of all superstructure metal work furnished under contract No. 2 and contract No. 3	3,149,000 lb.	$0.0275	$0.025
2. In conc. slabs steel spans	280,000 lb.	.0385	.052
3. Conc. in slabs and curbs on steel spans	1,125 c. y.	22.00	36.00
4. The lighting system complete.	L. S.	4,340.00	3,200.00
5. Toll house complete	L. S.	1,120.00	1,000.00

SEWAGE DISPOSAL WORKS KANSAS

OWNER: City of Hill City, Kansas; J. R. Gordon, clerk; Paulette & Wilson, Salina, engineers.

PROJECT: Construction of a sewage disposal system, including an Imhoff tank disposal plant and sewage collection system. Plant utilizes Imhoff tanks. There is no rock excavation, and local aggregate is available for concrete. Several concrete pavements are to be cut through.

Note: Unit prices given below are given as basis for additions to or deductions from the lump sum bid. Transportation by rail and highway is available.

BIDS: Eleven bids were received Oct. 28, 1938, ranging from the contract low of $64,500 to $80,141.

LOW BIDDERS:

1. Central Construction Co., Hoisington, Kan. (contract)	$64,500
2. C. L. Burt, Hutchinson, Kan.	67,300
3. Asplund Construction Co., Enid, Okla.	69,500

Item	Unit	UNIT PRICE
1. Dry earth excav	c. y.	$0.50
2. Wet earth excav	c. y.	4.00
3. Conc. cl. 2	c. y.	12.00
4. Conc. cl. 3	c. y.	17.00
5. Conc. cl. 4	c. y.	20.00
6. Reinf	lb.	.045
7. B. & S.C.I. pipe & fittings	ton	120.00
8. C.I. flanged pipe & fittings	ton	250.00
9. Crushed rock	ton	2.00
10. Trenching & B.F. 0 ft.–4 ft.	l. f.	.12
11. Trenching & B.F. 4 ft.–6 ft.	l. f.	.14
12. Trenching & B.F. 6 ft.–8 ft.	l. f.	.18
13. Trenching & B.F. 8 ft.–10 ft.	l. f.	.24
14. Trenching & B.F. 10 ft.–12 ft.	l. f.	.35
15. Trenching & B.F. 12 ft.–14 ft.	l. f.	.50
16. Trenching & B.F. 14 ft.–16 ft.	l. f.	.62
17. Trenching & B.F. 16 ft.–18 ft.	l. f.	.90
18. Trenching & B.F. 18 ft.–20 ft.	l. f.	1.20
19. 8 in. B & S — C.I. pipe	l. f.	2.50
20. 10 in. B & S — C.I. pipe	l. f.	3.00
21. Conc. cl. 2	l. f.	12.00
22. 6 in. V.C.P.	l. f.	.32
23. 8 in. V.C.P.	l. f.	.45
24. 10 in. V.C.P.	l. f.	1.00
25. 8 x 6 in. V.C. wyes	ea.	1.00
26. 10 x 6 in. V.C. wyes	ea.	1.00
27. 6 in. V.C. ⅛ bends	ea.	.75
28. 6 ft. brick M.H.	ea.	40.00
29. Drop M.H.	ea.	75.00
30. Variation in M.H. depth	ft.	3.00
31. Shallow brick M.H.	ea.	35.00
32. 6 ft. Br. flush tank	ea.	75.00
33. Shallow flush tank	ea.	50.00
34. Variation in F.T. depth	ft.	5.00
35. Lamp holes	ea.	10.00
36. ½-in. copper tubing	l. f.	.35
37. Supplying line appurtenances	ea.	10.00

HIGHWAYS, NEW MEXICO

OWNER: U. S. Bureau of Public Roads, Denver office. B. W. Matteson, engineer.

PROJECT: Grading, drainage, structures and surfacing on 0.699 miles of highway in Apache National Forest, Catron county, New Mexico. Roadway width is 24 ft. and the thickness is 6 in.

BIDS: Nine bids were received Dec. 6, 1938, ranging from the contract low of $52,092 to $73,514.

LOW BIDDERS:

1. Brown Bros., Albuquerque, N. M. (contract)	$52,092
2. W. T. Bookout, Las Vegas, N. M.	57,194
3. F. D. Shufflebarger, Albuquerque, N. M.	59,721

Item	Quan.	UNIT PRICES (1)	(2)	(3)
1. Uncl. excav	29,000 c. y.	$0.34	$0.45	$0.45
2. Uncl. excav. struct	1,700 c. y.	1.00	1.00	1.20
3. Spl. overhaul	2,000 sta. y.	.03	.04	.02
4. Spl. overhaul	100 c.y.-mi.	.20	.30	.40
5. Obliteration of old roads	66 units	2.00	2.00	2.00
6. Cl A conc	646 c. y.	21.00	21.00	23.00
7. Cl. B conc	26 c. y.	21.00	21.00	19.00
8. Cl. D conc	185 c. y.	21.00	21.00	27.00
9. Reinf	91,300 lb.	.05	.06	.055
10. Struct. steel, incl. pipe drains guard angles, cast steel and gratings	200,300 lb.	.07	.065	.0725
11. Untr. timber, incl. bridge iron	0.248 M.b.m.	140.00	110.00	200.00
12. Tr. timber, creosote preservation incl. bridge iron	3 M.b.m.	140.00	140.00	180.00
13. 24-in. CGSM pipe	124 l. f.	2.50	3.42	3.00
14. 36-in. CGSM pipe	66 l. f.	5.00	6.00	6.00
15. 48-in. CGSM pipe	92 l. f.	7.00	10.00	8.00
16. Conc. maint. posts	5 ea.	4.00	5.00	5.00
17. 24-ft. Cattle guard	1 only	700.00	1,000.00	850.00
18. Barbed wire fence	2,400 l. f.	.06	.08	.06
19. 12-ft. gates	1 only	15.00	14.00	15.00
20. Selected material	3,000 c. y.	.36	.75	.45